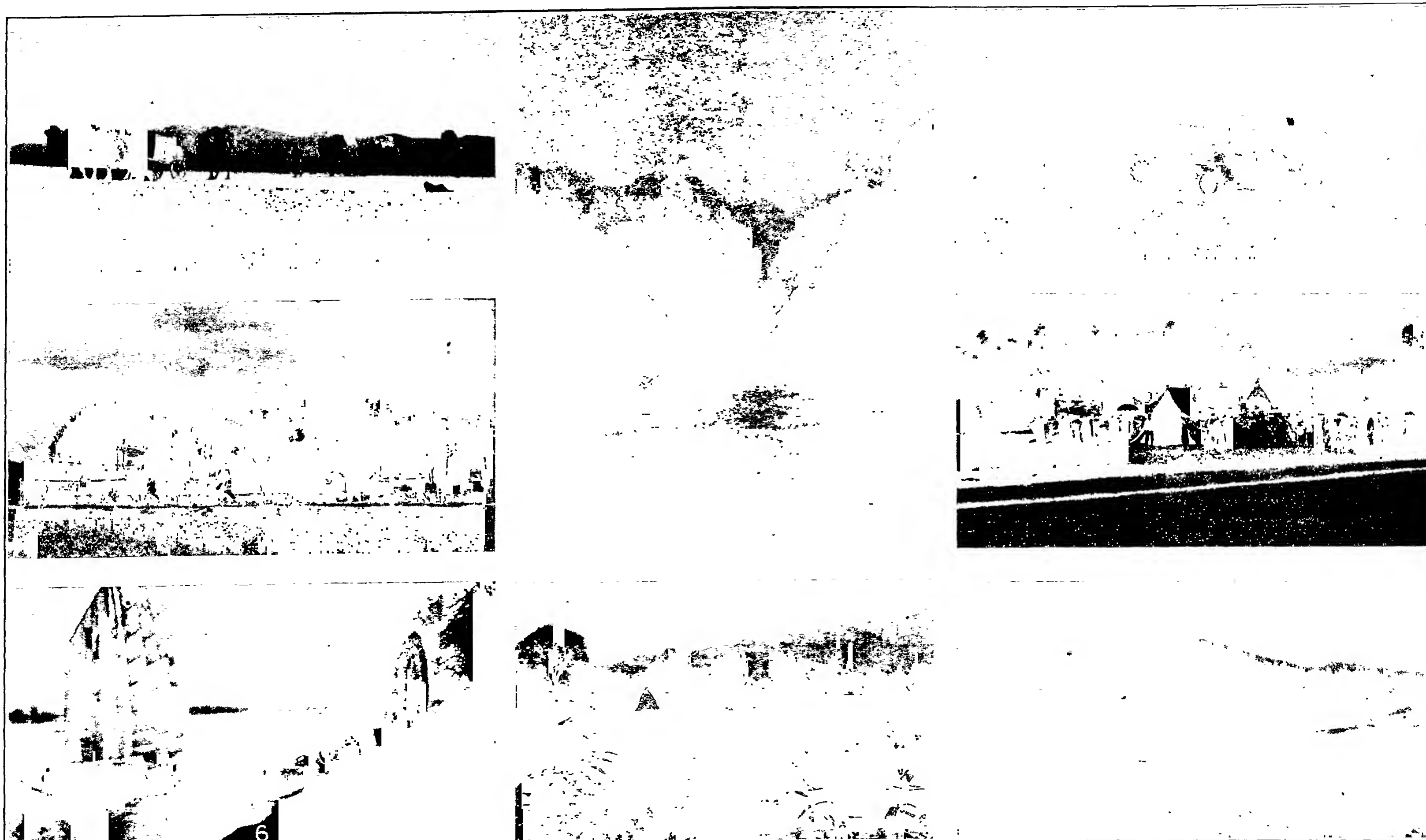

Typical Views of Magnetic Expeditions in Asia.

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RESEARCHES OF THE DEPARTMENT OF TERRESTRIAL MAGNETISM
VOLUME IV

LAND MAGNETIC OBSERVATIONS 1914-1920

BY

L. A. BAUER, J. A. FLEMING, H. W. FISK, AND W. J. PETERS

AND

SPECIAL REPORTS

J. A. FLEMING: Construction of Non-Magnetic Experiment Building of the Department of Terrestrial Magnetism
H. W. FISK: Dip-Needle Errors Arising from Minute Pivot-Defects
S. J. BARNETT: A Sine Galvanometer for Determining in Absolute Measure the Horizontal Intensity of the Earth's Magnetic Field
J. A. FLEMING: Results of Comparisons of Magnetic Standards, 1915–1921

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1914-1920

By L. A. Bauer, J. A. Fleming, H. W. Fisk, and W. J. Peters

LAND MAGNETIC OBSERVATIONS, 1914–1920.

INTRODUCTION.

This publication is the fourth of the series by the Department of Terrestrial Magnetism of the Carnegie Institution of Washington, bearing the general title "Researches of the Department of Terrestrial Magnetism." Each volume has a subtitle setting forth briefly its special contents. Thus the first volume, designated as Volume I and entitled "Land Magnetic Observations, 1905–1910," contains the results of all magnetic observations made on land by the Department from the beginning of its observational work in February 1905 to the end of December 1910. Volume II, "Land Magnetic Observations, 1911–1913, and Reports on Special Researches," contains the results of all magnetic observations made on land during the three years, January 1, 1911, to December 31, 1913. The titles of the special reports in that volume are: Research Buildings of Department of Terrestrial Magnetism, by L. A. Bauer and J. A. Fleming; Magnetic Inspection Trip and Observations during Total Solar Eclipse of April 28, 1911, at Manua, Samoa, by L. A. Bauer; Results of Comparisons of Magnetic Standards, 1905–1914, by L. A. Bauer and J. A. Fleming. Volume III, on "Ocean Magnetic Observations, 1905–1916, and Reports on Special Researches," contains the final results of the ocean magnetic observations made aboard the *Galilee* in the Pacific Ocean, 1905–1908, and aboard the *Carnegie* in the Atlantic, Indian, and Pacific Oceans, 1909–1914, together with preliminary results of the observations on the 1915–1916 portion of the *Carnegie's* cruise IV. The special reports of Volume III are as follows: Results of Atmospheric Electric Observations made aboard the *Galilee* (1907–1908), and the *Carnegie* (1909–1916), by L. A. Bauer and W. F. G. Swann; Some Discussions of the Ocean Magnetic Work, by L. A. Bauer and W. J. Peters.

The final reduction of the land magnetic observations given in the present volume (IV) was delayed by the Great War, both because of lack of computational assistance and the difficulty encountered in promptly obtaining required data from cooperating observatories and countries. In order to meet the demand from establishments engaged in the preparation of magnetic charts and geographic maps, preliminary magnetic and geographic data were supplied in manuscript according to requests received; thus immediate needs in advance of final publication were promptly met.

A future volume, in preparation, will be entitled "Ocean Magnetic Observations, 1915–1921, and Special Reports." The final reduction of the ocean magnetic observations was delayed for the same reasons as given for Volume IV. Preliminary results have been published promptly in the various issues of "Terrestrial Magnetism and Atmospheric Electricity," and in this manner, or by manuscript copies, hydrographic establishments have been kept informed of the data required for new, or revised, issues of magnetic charts.

With the completion of Volumes IV and V, it is possible to undertake the reduction of the accumulated magnetic data since 1905 to a common date for the construction of new world magnetic charts, and to make a new analysis of the Earth's magnetic field on the basis of more complete and more accurate data than heretofore available. But for the Great War, these objects of our magnetic-survey work would have been realized earlier.

The Director of the Department (L. A. Bauer) and the Chief of the Magnetic Survey Division (J. A. Fleming) desire to express their sincere appreciation and deep sense of obligation to those, especially to the observers and computers, whose devotion and unflagging interest have made possible the accumulation of the mass of scientific data presented in this volume.

One of the main objects to which the Department of Terrestrial Magnetism has devoted its energies since it was established in 1904—the general magnetic survey of the globe—has now been completed for the major part of the Earth. While this task has been accomplished chiefly through the labors of the Department, very notable contributions have been made by various countries, either through repetition of former magnetic surveys, or through new surveys. The work of the Department has been confined, in the main, to the oceans and to those countries or regions where, for one reason or another, magnetic data would not otherwise be obtained immediately. In some regions required magnetic surveys were accomplished by cooperation with existing organizations, or with interested investigators. The Department furthermore cooperated successfully with the Peary Arctic expedition, the Mawson Antarctic expedition, and the Amundsen Arctic expedition, now in progress; in this manner valuable data in polar regions were obtained. It is a pleasure to acknowledge the cordial and valuable aid received from magnetic institutions generally, as well as from government officials and diplomatic representatives of the countries visited; this aid has in no small measure contributed to the achievement of the desired object.

The land observers of the Department have performed their assigned duties in every major political subdivision of Africa, except British and Italian Somaliland; in every country of Asia, excepting Afghanistan, the Himalayan states, and Chosen, but including every province of China except Tibet; in every state of Australia; in New Zealand; in 11 European countries; in every country of North America; in Greenland and Iceland; in every country of South America; in the principal islands of the Atlantic and Indian Oceans; and in 25 of the principal groups and isolated islands of the Pacific Ocean.

The enumeration of stations has been made on the following basis: At base stations and at observatories where instruments are intercompared, every point at which observations are made is counted as a separate station; the same procedure has been followed with regard to locally disturbed areas where it is generally necessary to make observations at several points; reoccupied stations (repeat stations) are invariably counted as but one station, though it may happen at times that the reoccupied station is not quite the same as the original one. The enumeration of expeditions has been made in accordance with the time consumed, the general region traversed, and the character of the work performed.

Table 1 gives a summary of the land-survey work of the Department of Terrestrial Magnetism for the period 1905–1920.

TABLE 1.—*Summary of Land Operations, 1905 to 1920.*

Geographical divisions	Stations enumerated			Totals, 1905 to 1920			
	Volume			Stations	Occupations	C. I. W. repeat localities	Expeditions
	I 1905–1910	II 1911–1913	IV 1914–1920				
Africa	386	207	447	1040	1095	59	17
Asia	308	83	356	749	786	44	18
Australasia	10	284	315	609	640	33	15
Europe	36	38	24	96	112	10	3
North America	328	48	113	487	530	31	31*
South America	111	247	339	699	743	61	22
Islands, Atlantic Ocean	68	16	19	103	112	11	4
Islands, Indian Ocean	....	14	30	44	45	1	1
Islands, Pacific Ocean	51	16	104	171	179	8	7
Antarctic Regions	....	30	....	30	30	2	1
Totals	1298	983	1747	4028	4272	260	119

* Including expeditions engaged in minor operations and special work.

The general methods followed, both for the observational and the computational work, have continued the same as described in Volumes I and II. The instrumental equipments also, in general, have been the same as explained in the previous volumes. Except for slight modifications, as noted, the results have been tabulated in accordance with the conventions already adopted. The interested reader may be referred to Volumes I and II for any desired additional information, also for specimens of observations and of computations and descriptions of instruments.

DESCRIPTIONS OF INSTRUMENTS.

MAGNETOMETERS.

Since the publication of Volumes I, II, and III, the Department of Terrestrial Magnetism has not made any further material changes in the designs of magnetometers heretofore used. The designations of the types of magnetometers used for the work included in Volumes I, II, III, and IV are as follows:

1. The so-called theodolite-magnetometer type in three designs, viz: (*a*) and (*b*) of the Department of Terrestrial Magnetism, similar, respectively, to magnetometers Nos. 3 and 13, and (*c*) of the United States Coast and Geodetic Survey, similar to C. & G. S. No. 20.
2. The Kew type of magnetometer in two designs, with auxiliary theodolites for astronomical work, viz: (*a*) the regular design as constructed by Elliott Brothers, similar to No. 73, and (*b*) the Magnetic Survey of India design, similar to No. 36.
3. The light and portable type used in the Magnetic Survey of France, similar to No. 11.
4. The universal-magnetometer type in three designs, viz: (*a*) the design of Eschenhagen and constructed with modifications by Tesdorpf, similar to No. 2025; (*b*) the magnetometer-dip-circle design of the Department of Terrestrial Magnetism, similar to Nos. 14, 19, 20, 21, and 22; (*c*) the magnetometer-inductor design of the same Department, similar to Nos. 23, 24, 25, 26, 27, and 28.

The first three types, and design (*a*) of type 4, have been described and illustrated in detail on pages 2 to 7 of Volume I, while designs (*b*) and (*c*) of type 4 have been described and illustrated in detail on pages 5 to 12 of Volume II. Table 2 gives the details and constants of the various magnetometers used in the present work.

DIP CIRCLES AND EARTH INDUCTORS.

The dip circles used in obtaining the data given in the present volume were of the following patterns, of which the first two are fully described and illustrated in Volume I, pages 7 to 10, and the last in Volume II, pages 7 to 12: (*a*) the regular Kew land-pattern as made with slight variations by Dover and by Casella; (*b*) the Lloyd-Creak ship-pattern as originally designed by Captain Ettrick W. Creak and made by Dover with some modifications introduced by the United States Coast and Geodetic Survey and by the Department of Terrestrial Magnetism, according to L. A. Bauer's specifications; dip-circle attachment of universal magnetometer of type 4 (*b*).

The types of earth inductor used are fully described and illustrated in Volume I, pages 10 to 11, and in Volume II, pages 13 to 15, and include: (*a*) the design originated by Wild[1] and as modified by Eschenhagen represented in the Department's equipment by No. 48 constructed by Schulze, and No. 2 constructed by Toepfer and Son; (*b*) earth inductor of the type made by the Department of Terrestrial Magnetism for the determination of inclination at sea and as represented by earth inductors Nos. 3, 4, and 7; earth-inductor attachment of universal magnetometer of type 4 (*c*).

A list of the various dip circles and earth inductors which were used, together with the needles and their designations, will be found in Table 4, "Inclination Corrections on Adopted International Magnetic Standard for the Period 1914–1920," pages 12 to 18.

[1] Wild, H. Inductions-Inclinatorium neuer Construction und Bestimmung der Absoluten Inclination mit demselben in Pawlowsk. St. Petersburg, *Mem. Ac. Sc.*, ser. 7, vol. 38, No. 3, 1891.

TABLE 2.—*Details and Constants of Magnetometers Used, 1914–1920.*

[Magnetometers Nos. 2 to 10 inclusive were manufactured by the Bausch and Lomb Optical Company of Rochester, New York, and are all, except for minor mechanical details, of the same type, namely, 1(*a*), as described in Volume I; the magnets are hollow cylinders, the long magnets being 7.5 cm. long, 0.75 cm. inside diameter and 1.00 cm. outside diameter; the short magnets are 3.50 cm. long, 0.60 cm. inside diameter and 0.82 cm. outside diameter. Magnetometers Nos. 12 to 25 were manufactured in the instrument shop of the Department of Terrestrial Magnetism. Nos. 12, 13, 15, 16, 17, and 18 are of the theodolite-magnetometer type 1(*b*) as described in Volume I. Magnetometers 14, 19, 20, 21, and 22 are of the universal type 4(*b*) and magnetometers Nos. 23 to 28 are of the combined magnetometer and earth-inductor type 4(*c*), as described in Volume II. The magnets for Nos. 12 to 28 inclusive are all of the same type, being hollow cylinders made as nearly perfect as mechanically possible, the long magnets having the length 5.60 cm., inside diameter 0.60 cm., outside diameter 0.79 cm.; short magnets, length 2.60 cm., inside diameter 0.45 cm., outside diameter 0.65 cm. The suspension used for all the instruments is phosphor-bronze ribbon, this material replacing the use of silk entirely in the field work of the Department. The deflection distances provided for magnetometers Nos. 2 to 10 inclusive are 25, 27.5, 30, 35, and 40 cm., and for magnetometers 12 to 28 inclusive, 20, 25, and 28 cm.]

[The C. G. S. system of units is used throughout the table; the value of q is given for 1° C.]

Number	Type	Diameter horizontal circle	Moments of long magnets at 20° C.		Logarithm of π^2K at 20° C.	Distribution coefficients[1]		Induction coefficient h	Temperature coefficient q	Scale value for declination	Remarks
			Inertia, K	Magnetic at 1917.5		P	Q				
		cm.								′	
2	1(*a*)	12.5	162	600	3.20480	+15.78	−1000	0.0116	0.00035	1.50	
3	1(*a*)	12.5	166	658[2]	3.21487	+10.71	+1000	0.0088	0.00041	1.49	Department standard.
4	1(*a*)	12.5	156	620	3.18866	+14.87	− 881	0.0116	0.00035	1.49	
5	1(*a*)	12.5	234	612	3.36323	+14.07	......	0.0063	0.00051	1.48	
6	1(*a*)	12.5	243	538	3.37947	+13.61	− 361	0.0078	0.00046	1.48	
7	1(*a*)	12.5	239	600	3.37222	+13.31	......	0.0063	0.00045	1.49	
8	1(*a*)	12.5	237	480	3.36968	+14.67	+ 24	0.0063	0.00037	1.48	
8[3]	1(*a*)	12.5	237	480	3.36946	+15.29	− 461	0.0063	0.00030	1.48	After Apr. 1918.
9	1(*a*)	12.5	240	430	3.37449	+15.01	− 468	0.0078	0.00044	1.48	
10	1(*a*)	12.5	238	560	3.37081	+13.25	+ 490	0.0063	0.00035	1.52	Before July 1915.
10[4]	1(*a*)	12.5	238	560	3.37029	+13.86	......	0.0063	0.00035	1.51	After Aug. 1916.
12	1(*b*)	10.1	66	292	2.81398	+ 7.74	......	0.0096	0.00045	2.03	
13	1(*b*)	10.1	66	280	2.81219	+ 7.73	......	0.0101	0.00058	2.05	
14	4(*b*)	10.1	66	278	2.81084	+ 7.86	......	0.0093	0.00060	1.95	
14[5]	4(*b*)	10.1	69	278	2.83348	+ 7.86	......	0.0097	0.00058	1.96	After Feb. 1917.
16	1(*b*)	10.1	64	285	2.80365	+ 7.52	......	0.0087	0.00047	1.93	
16[6]	1(*b*)	10.1	64	285	2.80248	+ 7.52	......	0.0087	0.00045	1.93	After May 1918.
17	1(*b*)	10.1	65	287	2.80892	+ 7.51	......	0.0094	0.00049	1.96	
17[7]	1(*b*)	10.1	65	287	2.80888	+ 7.51	......	0.0094	0.00046	1.96	After July 1915.
18	1(*b*)	10.1	65	303	2.80595	+ 7.61	......	0.0086	0.00032	1.95	
19	4(*b*)	12.0	65	285	2.81041	+ 7.71	......	0.0091	0.00048	2.15	
20	4(*b*)	12.0	65	283	2.80742	+ 7.73	......	0.0091	0.00049	2.14	
20[8]	4(*b*)	12.0	65	283	2.80671	+ 7.73	......	0.0093	0.00050	2.14	After Apr. 1915.
21	4(*b*)	12.0	65	232	2.81042	+ 7.66	......	0.0112	0.00052	2.15	
21[9]	4(*b*)	12.0	65	232	2.81030	+ 7.66	......	0.0112	0.00050	2.15	After Aug. 1916.
24	4(*c*)	10.2	65	305	2.81017	+ 7.67	......	0.0094	0.00051	1.97	
25	4(*c*)	10.2	65	304	2.80522	+ 7.74	......	0.0095	0.00045	1.97	
25[10]	4(*c*)	10.2	65	304	2.80408	+ 7.74	......	0.0093	0.00045	1.97	After July 1919.
26	4(*c*)	10.2	65	320	2.80387	+ 7.79	......	0.0083	0.00044	1.97	
27[11]	4(*c*)	10.2	64	310	2.79850	+ 7.63	......	0.0105	0.00050	1.97	
28	4(*c*)	10.2	66	325	2.81081	+ 7.80	......	0.0081	0.00048	1.97	
9710[12]	1(*b*)	10.1	67	275	2.82157	+ 8.20	......	0.0103	0.00025	2.00	

[1] When no values are entered for Q the values given for P are the values of P', assuming that $(1 + P'r^{-2}) = (1 + Pr^{-2} + Qr^{-4})$; this implies that the theoretical condition, $Q = 0$, holds, since the dimensions of magnets were selected accordingly.

[2] Value given in Table 1, page 6, of Volume II is a misprint and should read 664 instead of 624.

[3] Instrument was remade in April 1918 and specially adapted for the field work in the Arctic of the "Maud Expedition" of Captain Roald Amundsen.

[4] Instrument was overhauled and repaired during July 1915 and Aug. 1916; it was not used in the field during the interim.

[5] Instrument was remade during Nov. 1916 to Feb. 1917.

[6] Instrument was reconstructed during April to May 1918.

[7] Instrument was damaged by an accident on July 24, 1914, in the field; it was remade during June to July 1915.

[8] Instrument was damaged by an accident on Oct. 5, 1914, in the field; it was remade during Feb. to April 1915 for the Dominion Astronomical Observatory, Ottawa, Canada.

[9] Instrument was overhauled and repaired during Aug. 1916.

[10] Instrument was overhauled and repaired during July 1919.

[11] Constructed for the Moscow University, Moscow, Russia.

[12] Manufactured by C. L. Berger and Sons for University of Texas, Austin, Texas; similar to theodolite-magnetometer of type 1(*b*) as constructed by Department of Terrestrial Magnetism. Deflection distances used were 22 and 25 cm.

INSTRUMENTS FOR THE AMUNDSEN ARCTIC EXPEDITION.

As the result of a conference in April 1918 between Captain Roald Amundsen, Dr. Fridtjof Nansen, and the Director, certain minor modifications were decided upon in the C. I. W. instruments to be supplied by the Department for the magnetic observations it was proposed to undertake on the Amundsen Arctic Expedition (the "Maud Expedition"). These modifications, none of which altered the intrinsic design of the instruments, were based upon the following considerations resulting particularly from the Arctic experiences of Dr. Nansen, Captain Amundsen, and Mr. Peters of the Department:

(*a*) Difficulties arising from extreme cold, condensation that occurs from lamps and the proximity of the uncovered hands as well as the breath, and the lack of delicate touch and the necessity of wearing mits; these difficulties, of course, apply chiefly to the work in winter.

(*b*) Any one instrument should have the least possible number of parts to be assembled, thus permitting rapid unpacking and assembling, and dismounting and repacking.

(*c*) All clamping screws, tangent screws, and other metal parts of the instrument which must be touched with bare fingers during adjustment, or observation, should be suitably covered with non-conducting materials; such covers should also be made of sufficient size to facilitate delicate clamping and adjustment with numbed fingers.

(*d*) All glass lying between the observer's eye, and the graduation, scale, or object that he must read or observe, should be readily accessible for removal of condensation. (For observations in extreme cold it is necessary to refrain, as much as possible, from breathing on the instrument.)

The C. I. W. magnetometer No. 8 of the Department's type 1 (*a*) and Dover dip-circle No. 205 were selected as instruments most nearly answering the requirements specified by Captain Amundsen. They were modified and altered by providing all parts subject to handling in use and adjustment in the field with celluloid covers. The hood connection between the magnetometer-telescope and its house was altered so as to eliminate the necessity of fitting the hood to the telescope when assembling the instrument. This was accomplished by the addition of a spherical-ended cap on the objective end of the telescope, arranged to make contact with a velvet-lined, concave mounting attached to the magnetometer-house (this arrangement is similar to that used on the later types of C. I. W. magnetometers). Celluloid grips were also mounted on the reversing bar-magnets of the dip circle. The arresting device for the compass attachment of the dip-circle was altered by an eccentric mechanism to facilitate clamping and unclamping of the needle. A special lifting device was made by which the dip needles could be lifted off the agate supports and turned face about without opening the magnet-house; however, as its operation seemed to involve some danger of accident to the needles, this attachment was removed from the instrument before it was sent away. A more detailed idea of the modifications which were made may be obtained by an inspection of Plate 2 which shows various views of the magnetometer and dip circle.

MAGNETIC INSTRUMENTS FOR AMUNDSEN ARCTIC EXPEDITION ("MAUD EXPEDITION").

1. Theodolite of magnetometer.
2. Magnetometer on tripod.
3. Dip circle, showing also special tripod-clamps.
4. Dip circle and appurtenances.

REDUCTIONS TO STANDARD INSTRUMENTS.

MAGNETIC STANDARDS ADOPTED.

The Department's extensive intercomparisons of magnetic instruments at Washington, in the field, and at magnetic observatories in all parts of the Earth have made it possible to refer its data to provisional "International Magnetic Standards." Such data obtained prior to 1914 were discussed in detail in Volume II, pages 211 to 278; the corresponding data obtained during 1915 to 1920, which will be given later in a special report, bear out, in general, the conclusions reached in Volume II. The "International Magnetic Standards," as stated, are provisional, particularly for intensity, pending the completion and intercomparison of absolute instruments[1] designed to determine magnetic intensity by electric methods.[2] Meanwhile the numerous comparisons with magnetic observatory standards indicate that these provisional standards approach sufficiently close to probable international ones that they may be considered as fulfilling all practical requirements of a general magnetic survey of the Earth.

Accordingly, these provisional "International Magnetic Standards," designated I.M.S., have been adopted for the results contained in this volume. The results already published in Volumes I, II, and III were reduced to the standards, designated C.I.W., adopted before the compilation of intercomparison data made possible the adoption of provisional "International Magnetic Standards"; they may be referred to I.M.S. by the following relations:

Declination, D:	I.M.S. = C.I.W. − 0′.1
Inclination, I:	I.M.S. = C.I.W. + 0′.5
Horizontal intensity, H:	I.M.S. = C.I.W. − 0.00015H

The instruments used as standards by the Department during 1914 to 1920 were the same as those used prior to 1914 for results given in Volumes I and II, viz: In declination, C.I.W. magnetometer No. 3 with correction on I.M.S. of −0′.1 to observed values; in horizontal intensity, C.I.W. magnetometer No. 3 with zero correction on I.M.S. to observed values; in inclination, earth inductor No. 48, made by Schulze, with zero correction on I.M.S. to observed values.

MAGNETOMETER CORRECTIONS.

The corrections of each magnetometer on the adopted standard were determined at Washington, before and after use of the instrument in the field, and also, whenever possible, in the field by means of intercomparisons with other outfits. The accuracy of

[1] The Schuster-Smith magnetometer, constructed at the National Physical Laboratory, and the sine galvanometer, designed by Dr. S. J. Barnett and constructed by the Department of Terrestrial Magnetism, were completed early in 1921. It is greatly hoped that the expectations as regards high absolute precision of intensity determinations with these instruments may be fully realized and that early intercomparisons may be possible between them and standard magnetometers of different countries, in order to assist in determining upon international magnetic standards.

[2] See L. A. Bauer, *Terr. Mag.*, vol. 19, pp. 1–18, 1914; N. E. Dorsey, *Terr. Mag.*, vol. 18, pp. 1–38, 1913; W. A. Jenkins, *Phil. Mag.*, vol. 26, pp. 752–774, 1913; E. Mauz, *Physic. Zs.*, vol. 22, pp. 11–15, 1921; A. Schuster, *Terr. Mag.*, vol. 19, pp. 19–22, 1914; A. Tanakadate, *Proc. R. S. Edinburg*, vol. 12, 1883 to 1884, and *J. Coll. Sci.*, Tokio, vol. 2, pp. 160–262, 1888; N. Watanabe, *Proc. Phys.-Math. Soc. Japan*, ser. 3, vol. 2, pp. 210–223, 1920; W. Watson, *Phil. Trans. R. A.*, ser. A, vol. 198, pp. 431–462, 1902.

the mean correction is usually within about 0′.2 in declination and about 0.0001H in horizontal intensity. The tabulated corrections are to be applied algebraically, east declination being reckoned as positive and west declination as negative; horizontal intensity is always taken as positive.

It will be noted that for some of the instruments the H-corrections vary with time; this is because of gradual change with time during field use in the moment of inertia, K, of the long magnet system. That such changes take place, particularly in the tropics and for magnets sheathed with brass, and that in general they are closely linear with time, is shown clearly by discussion of the results from numerous intercomparisons at Washington to be contained in a later special report. In some cases the final values as given in Table 2, of the distribution coefficients, P and Q or P', which result from compilations of available data through 1920, differ from the values used for the original constants and computations; for several of the instruments the same remark applies for the final value of logarithm π^2K as given in Table 2. The tabulated H-corrections shown by Table 3 apply for the constants given in Table 2. The special report to be entitled "Discussion of Magnetometer Constants and Corrections on Standards" will give in detail the reduction-factors involving changes in constants and modifications of these constants with the gradual accumulation of data which tend to eliminate in the mean the unavoidable accidental errors.

TABLE 3.—*Magnetometer Corrections on Adopted I. M. S. for the Period 1914 to 1920.*

No. of magnetometer	Correction to observed: Declination	Correction to observed: Horizontal intensity	Remarks
	′		
2	0.0	−0.00025H	
3	−0.1	0.00000H	Standard instrument.
4	+0.3	+0.00009H	
5	−0.9	−0.00054H	
5	−0.2	−0.00054H	After overhauling of July 1919.
6	+0.1	+0.00060H	
7	−0.2	−0.00054H	
8	0.0	−0.00032H	
8	−0.7	−0.00033H	After remaking of Apr. 1918.
9	−0.3	−0.00077H	
10	0.0	+0.00027H	
10	−0.5	+0.00040H	After overhauling of July 1915 and Aug. 1916.
12	−0.4	−0.00063H	
12	−0.4	−0.00063H − (t−1915.00) 0.00030H	From Jan. 1915 to June 1917.
13	−0.5	−0.00099H[1]	From June to Nov. 1914.
13	−0.5	−0.00123H[1]	June 1918.
13	−0.5	−0.00137H[1]	From Feb. 1918.[1]
14	−0.6	−0.00017H at 1911.4 −0.00064H at 1914.0 −0.00083H at 1914.5 −0.00097H at 1915.0 −0.00106H at 1915.5 −0.00110H at 1916.0 −0.00111H at 1916.5	Inertia-change with time was not linear.
14	−0.2	−0.00078H	After remaking of Nov. 1916 to Feb. 1917.
16	−0.4	−0.00046H − (t − 1914.08) 0.00050H	From Feb. 1914 to June 1915.
16	−0.4	+0.00011H	After reconstruction of Apr. to May 1918.

[1] There is a variation in the H-correction because of change in K (moment of inertia of long magnetic system) for this instrument while in field use at the rate of about −0.0003H per year during 1915; the instrument was not in field use again until June 1918, and the indicated annual effect because of change in K on H-correction is only −0.00007H between 1915 and 1919. Pending the first opportunity for new determination of K and re-standardization observations upon return of instrument from field, values of H-correction are adopted as given. The H-correction from comparisons at Washington, referred to same constants, was −0.00001H at 1910.15.

TABLE 3.—*Magnetometer Corrections on Adopted I. M. S. for the Period 1914 to 1920*—Continued.

No. of magnetometer	Correction to observed		Remarks
	Declination	Horizontal intensity	
	′		
17	+0.1	$+0.00033H - (t - 1911.35)\ 0.00020H$	
17	−0.9	$+0.00033H - (t - 1911.35)\ 0.00020H$	Change in *D*-correction at field accident of July 24, 1914.
17	−0.3	$+0.00003H - (t - 1915.77)\ 0.00038H$	After reconstruction of June to July 1915.
18	−0.2	$+0.00011H - (t - 1916.17)\ 0.00027H$	
19	−0.4	$+0.00020H - (t - 1912.69)\ 0.00046H$	From Sept. 1912 to Sept. 1915.
20	+0.3	$-0.00016H - (t - 1912.96)\ 0.00031H$	
20	−0.7	$-0.00016H - (t - 1912.96)\ 0.00031H$	Change in *D*-correction at field accident of Oct. 5, 1914.
20	−0.7	$-0.00023H$	After reconstruction of Feb. to Apr. 1915.
21	−0.8	$-0.00044H$	After accident of Dec. 1913 and repairs of Feb. 1914.
21	−0.1	$0.00000H$	After overhauling of Aug. 1916.
21	−0.1	$-0.00082H$[1]	During Jan. 1917 to July 1918.
24	−0.3	$+0.00006H$	
25	−0.3	$+0.00008H - (t - 1914.22)\ 0.00026H$	
25	−0.1	$0.00000H$	After overhauling of July 1919.
26	−0.8	$+0.00025H$	
27	−0.4	$-0.00017H$	
28	−0.3	$-0.00028H$	
9710	+0.4	$-0.00024H$	

[1] There is indication of a change in K during the observer's ocean trip to Peru after Washington standardizations of Aug. 28 to Sept. 1, 1916; the value used for field observations during January 1917 to July 1918 is controlled by comparisons in January 1917 at Arequipa with C. I. W. magnetometer No. 10 and in July 1918 with standard C. I. W. magnetometer No. 3 at Washington, the values being $-0.00072H$ and $-0.00090H$ respectively.

INCLINATION CORRECTIONS.

As in the past for determinations of inclination with the dip circle, the polarity of the needle is invariably reversed, eliminating any so-called balance-error due to eccentric position of the center of gravity of the needle. There remains, however, the error due to irregularity of figure of pivot, and this will vary, in general, with the angle of inclination. Hence the determinations of needle-corrections at a base-station, however carefully executed, may not necessarily apply to a region of different inclination. The wide field experience of the Department had already indicated by 1910 that in order to obtain reliable results with a dip circle, it was necessary to observe at each station, whenever possible, with 4 needles, and, furthermore, to obtain at every opportunity, control of the dip-needle corrections by comparisons with other dip circles and, in particular, with earth inductors. From the accumulated observational data, it was frequently possible to establish relations by least-square adjustments for each needle in the form

$$F\Delta I = x + z \cos I + y \sin I$$

in which F is the total intensity, I is inclination, ΔI is the needle-correction on standard, and x, z, and y are coefficients obtained by the method of least squares.

Unfortunately, even when reliable comparison-data were available, the development of tiny rust-spots on the pivots in the course of field work, especially in tropical regions, has made it necessary in almost every case to depend for the corrections upon a critical study of observed needle-differences. The prime purpose of such a discussion has been to adjust the values obtained from each of the 4 needles to the mean of all, and to determine upon the allowable ranges in the inclination results, for guidance in rejection of any values. The large accumulation by the Department of well-distributed inclination data during 1914 to 1920 has furnished material for some interesting discussions of the effects of minute pivot-defects (see pages 359 to 371 of this volume).

On the other hand, the successful and somewhat extended use of the Department's design of field earth-inductor in several difficult expeditions has shown it to be an instrument of relatively high, absolute precision. It is noteworthy that numerous intercomparisons, covering extreme ranges in inclination and involving various types of inductor, show the corrections for inductors on standard to be practically constant for every value of inclination, and certainly well within the limit of accuracy of observation possible with vertical circles of the sizes used. An inspection of the corrections on standard for various earth-inductors and comparison with those for various dip-circles, as given in Table 4, points forcibly to the desirability of replacing the dip circle by the inductor wherever possible, both in the field and at observatories.

The inclination corrections adopted for the various instruments, used in the observations contained in this volume, are given in Table 4; these corrections are to be applied algebraically, regarding inclination, north end of needle down as positive, and south end of needle down as negative.

Table 4 also gives the corrections for the compass attachments of the dip circles; these corrections are to be applied algebraically to observed results, regarding east declination as positive and west declination as negative.

TABLE 4.—*Inclination Corrections on Adopted International Magnetic Standard for the Period 1914–1920.*

Instrument	Type[1]	Inclination	Corrections for needle				Tabular designation	Correction for compass	Remarks
			No. 1	No. 2	No. 5	No. 6			
Universal magnetometer 14	4(*b*)	+58° to +71°	+0′.3	+0′.4	+0′.1	−2′.0	14.1256	....	Minor field repairs in Feb. 1914. Used during Feb. 1914 to Aug. 1916 in Australasia, Pacific Islands, and United States.
		− 2°	+0 .5	−2 .6	+0 .3	−0 .2			
		− 5	0 .0	−1 .9	−0 .2	+0 .1			
		−10	−0 .7	−0 .9	−0 .6	+0 .2			
		−15	−1 .1	−0 .4	+0 .7	−1 .2			
		−20	−0 .1	−0 .5	−0 .6	−0 .8			
		−25	−0 .9	−0 .5	−1 .3	+0 .7			
		−30	−0 .6	−0 .3	−1 .3	+0 .2			
		−35	−0 .2	−0 .6	−0 .7	−0 .5			
		−40	+0 .5	−0 .3	−0 .9	−1 .3			
		−45	+0 .8	−0 .6	−1 .2	−1 .0			
		−50	+0 .6	−0 .7	−1 .1	−0 .8			
		−55	0 .0	−0 .7	−0 .7	−0 .6			
		−60	0 .0	−0 .6	−0 .4	−1 .0			
		−65	−0 .5	−0 .6	−0 .2	−0 .7			
		−72	−1 .2	−1 .1	−0 .1	+0 .4			
			No. 1	No. 5					
Universal magnetometer 14	4(*b*)	+67° to +71°	+1′.2	−1′.7	....	....	14.15	....	Reconstructed during Nov. 1916 to Feb. 1917. Used during June 1918 in United States.
			No. 2	No. 5	No. 6				
Universal magnetometer 19	4(*b*)	−15° to +23°	+1′.1	+0′.8	−0′.5	....	19.256	....	Used during March to Nov. 1914 in West Indies and South America. Because of pivot deterioration all values by needle 1 and all by needle 2 between $I=+3°$ and $I=+49°$ were rejected.
		+48 to +49	....	+0 .8	−0 .5	....	19.56		
			No. 1 of 21	No. 2 of 21					
Universal magnetometer 19	4(*b*)	−15° to +23°	−1′.2	−1′.4	....	....	19.(12)	....	Used during March to Sept. 1915 in South America. Needles 2 and 6 of 19, used at a few stations, were rejected because of pivot deterioration.

[1]For explanation of types, see p. 6.

TABLE 4.—*Inclination Corrections on Adopted International Magnetic Standard for the Period 1914–1920*—Continued.

Instrument	Type[1]	Inclination	Corrections for needle				Tabular designation	Correction for compass	Remarks
			No. 1	No. 2	No. 6	No. 5 of 21			
Universal magnetometer 20......	4(*b*)	+10°	−3′.3	−1′.7	+0′.7	....	20.126 or 20.12(56) (See remarks)	....	Used during Jan. to Dec. 1914, in western Africa. Needles 5 and 6 of 21 were substituted in July for needles 5 and 6 of 20. The correction for all values of inclination by 6 of 20 was +1′.0.
		+ 5	−1 .9	−0 .9	−0 .3	....			
		0	0 .0	0 .0	−1 .1	−2′.3			
		− 2	+0 .6	+0. 3	−1 .1	+0 .7			
		− 4	+1 .3	+0 .5	−1 .0	+2 .3			
		− 6	+1 .8	+0 .8	−0 .8	+3 .1			
			No. 3 of 19	No. 4 of 19	No. 3 of 20	No. 4 of 20			
Universal magnetometer 21......	4(*b*)	+71°	−0′.8	−1′.1	+1′.7	+0′.1	21.(343)4	....	Used in Venezuela and Brazil during March to Oct. 1914, after extensive repairs and readjusting in Feb. 1914, because of accident in Dec. 1913.
		+40	−0 .2	+1 .7	−2 .3	+0 .9			
		+36	+1 .0	+1 .2	−1 .3	−0 .6			
		+32	+0 .2	+1 .7	+0 .1	−2 .0			
		+28	+0 .2	+1 .6	−0 .9	−0 .8			
		+24	−0 .5	+1 .9	−0 .6	−0 .9			
		+20	−0 .5	−0 .3	+1 .1	−0 .3			
		+18	+0 .3	−1 .3	+1 .1	−0 .1			
			No. 1 of 19	No. 3 of 19	No. 5 of 20	No. 6 of 20			
Universal magnetometer 21......	4(*b*)	+35°	+2′.4	−1′.3	−3′.3	−2′.3	21.(1(356) or 21.12(3(6)	....	Used during Sept. 1916 to July 1918, after general overhauling and readjusting in Aug. 1916, in Jamaica, Ecuador, Peru, Chile, Bolivia, Brazil, and the Guianas. Because of erratic behavior it was necessary to reject a large number of results by needles 1 of 19 and 5 of 20, which were, therefore, replaced after tests at La Paz in June 1917 by needles 1 and 2 of 21.
		+30	+0 .9	−1 .0	−2 .5	−1 .8			
		+25	−0 .2	−0 .6	−2 .4	−1 .1			
		+20	−0 .2	−0 .9	−2 .2	−1 .1			
		+15	+0 .7	−1 .5	−1 .6	−1 .9			
		+10	+0 .6	−2 .0	−1 .6	−1 .3			
		+ 5	+0 .3	−2 .0	−2 .4	−0 .3			
		0	+1 .0	−1 .9	−2 .9	−0 .6			
		− 5	+3 .0	−2 .1	−2 .7	−3 .0			
		−10	+2 .4	−2 .7	−1 .2	−3 .0			
		−15	+2 .2	−3 .1	−0 .8	−2 .7			
		−20	+2 .7	−3 .8	−0 .3	−2 .9			
		−25	+2 .2	−4 .4	+0 .8	−3 .0			
		−30	+2. 1	−5 .0	+1 .4	−3 .0			
		−35	+2 .2	−5 .4	+1 .6	−2 .8			
			No. 1 of 21	No. 2 of 21					
		+35	−0′.4	−0′.3	....	....			
		+30	−1 .0	−0 .7	....	....			
		+25	−1 .6	−1 .0	....	....			
		+20	−2 .0	−0 .3	....	....			
		+15	−1 .6	+0 .6	....	....			
		+10	−1 .2	+0 .2	....	....			
		+ 5	−1 .1	−1 .0	....	....			
		0	−0 .2	−1 .6	....	....			
		− 5	+0 .2	−1 .8	....	....			
			No. 2 (*a*)	No. 2 Dover (*a*)					
Casella circle 23...	(*a*)	+60°			....	....	23.2(2)	....	(*a*) Correction for observed *I* by 2 needles was −3′.2. Property of United States Coast and Geodetic Survey.
			No. 1	No. 2	No. 3	No. 4			
Barrow circle 38...	(*a*)	−58° to −68°	0′.0	0′.0	0′.0	0′.0	38.1234	....	Property of the Sydney Observatory. Used during Sept. 1914 to Jan. 1918 in Australia.
		−66 to −67	+4 .1[2]	+3 .2[2]	−0 .2[2]	−0 .2[2]			

[1] For explanation of types, see p. 6.

[2] These corrections, determined from comparisons with circle 226, apply after Oct. 1917, when a new pivot was made for needle 1 and the pivots of the other needles were trued up. Government Astronomer Dodwell states that, prior to these repairs, comparison in March 1916 of needle 1 only with circle 226 showed practical agreement of observed inclinations; there being no other comparison data, the corrections prior to Oct. 1917 were adopted as zero, since correction of circle 226 is small.

TABLE 4.—*Inclination Corrections on Adopted International Magnetic Standard for the Period 1914–1920*—Continued.

Instrument	Type[1]	Inclination	Corrections for needle				Tabular designation	Correction for compass	Remarks
			No. 5	No. 1 of 178	No. 2 of 178				
Barrow circle 41...	(*a*)	−56°	+0′.2	−2′.0	+6′.3	....	41.5(12)	....	Property of the Melbourne Observatory. Used during April to July 1914 in Australia. Needle 6 was also used, but because of erratic behavior all results with it have been rejected.
		−57	+0 .2	−1 .1	+5 .0	....			
		−58	+0 .2	−1 .5	+3 .4	....			
		−59	+0 .2	−2 .2	+2 .1	....			
		−60	+0 .2	−1 .4	+1 .6	....			
		−61	+0 .2	+1 .2	+2 .9	....			
			No. 1	No. 2					
Dover circle 154...	......	+77° to +86°	....	....	....	....	154.12	....	Used since 1918 by the *Maud* Expedition of Captain Amundsen.
			No. 5	No. 6					
Lloyd-Creek circle 169.	(*b*)	+71° to +87°	−0′.2	−1′.0	....	....	169.567 (See remarks)	−1′.6(*a*) −3 .8(*b*)	(*a*) When mark read by telescope; (*b*) when mark read by peep-sights. Instrument overhauled and readjusted during early part of June 1914. Used during June to Oct. 1914 in Canada, Labrador, and Hudson Bay, and during March 1918 in United States. Correction for needle 7 deflected by needle 8 in total-intensity work, short distance +4′.4, long distance +4′.2; log C_l=9.68338, log C_d for short distance =9.49153, log C_d for long distance = 9.34509, all at 20° C., the effect of one degree change in temperature being 0.00010.
			No. 1	No. 2	No. 5	No. 6			
Dover circle 172...	(*a*)	−67° to −72°	−6′.4	+2′.5	−2′.7	−4′.6	172.1256	0′.0	Used during Jan. and March 1914 in Australia.
			No. 2	No. 5	No. 7 of 178	No. 8 of 178			
Dover circle 172...	(*a*)	−35°	+0′.6	+3′.6	−1′.8	−3′.3	172.25(78)	0′.0	Used during March to Nov. 1914 in Australia and during Feb. to March 1915 at Canton, China. For inclination +32° to +33°, correction used for observed mean of 4 needles was +0′.7.
		−37	−1 .0	−0 .6	−0 .9	+1 .5			
		−38	−2 .0	0. 0	−1 .0	+1 .8			
		−40	−0 .6	+0 .4	−1 .3	+0 .4			
		−45	−1 .0	0 .0	−1 .5	+1 .4			
		−50	−0 .8	−0 .6	−1 .2	+1 .4			
		−55	−0 .6	−1 .0	+0 .1	+0 .4			
		−60	0 .0	−0 .5	−0 .6	−0 .5			
		−65	+1 .3	−0 .1	−1 .4	−1 .2			
		−68	+2 .7	−2 .4	−1 .8	−0 .1			
			No. 1	No. 2	No. 5	No. 6			
Dover circle 177...	(*a*)	−62°	0′.0	−0′.5	−1′.2	−1′.4	177.1256	−0′.5	Instrument overhauled during March 1914. Used during Aug. to Dec. 1914 in Australia.
		−63	−0 .8	−0 .3	−0 .1	−1 .6			
		−64	−0 .7	−0 .7	+0 .8	−1 .4			
		−65	−0 .2	−1 .1	0 .0	−1 .0			
			No. 1	No. 2	No. 5	No. 6			
Dover circle 177...	(*a*)	+30°.8	+0′.4	−0′.8	−0′.3	+1′.0	177.1256	−0′.5	Used during Feb. to July 1915 in China. Needle 6 shows erratic behavior, particularly between +34° and +38°.
		+33	−0 .3	0. 0	+0 .5	+0 .7			
		+34	0 .0	+0 .1	+0 .5	+2 .5			
		+35	0 .0	−0 .1	+0 .1	+7 .2			
		+36	−0 .2	+2 .4	+0 .1	+1 .5			
		+37	+0 .5	−1 .0	−0 .5	−4 .8			
		+38	+0 .5	+0 .7	−0 .9	+0 .4			
		+39	+0 .1	−0 .7	0 .0	+2 .1			
		+40	−0 .1	+0 .1	−0 .2	+1 .3			
		+41	+1 .0	0 .0	−0 .8	+0 .6			
		+42	−0 .7	−0 .2	0 .0	+0 .1			
		+43	−0 .8	−0 .3	+0 .4	+0 .6			
		+49	−0 .8	+0 .2	−0 .5	+1 .1			

[1] For explanation of types, see page 6.

TABLE 4.—*Inclination Corrections on Adopted International Magnetic Standard for the Period 1914–1920*—Continued.

Instrument	Type[1]	Inclination	Corrections for needle				Tabular designation	Correction for compass	Remarks
Dover circle 177...	(*a*)		No. 1	No. 2	No. 5	No. 6	177.1256	−0′.5	Used extensively during Aug. 1915 to Oct. 1916 in China. The behavior of the needles during Aug. 1915 to July 1916 was quite irregular, and the corrections vary rapidly with relatively small changes in inclination. For a discussion of these variations, see p. 364. The values given show the general character, though some of the minor-phase changes are lost since the maximum or minimum points fall between even degrees of inclination.
		+52°	+0′.2	+1′.1	−1′.1	+6′.0			
		+53	−0 .4	+0 .9	0 .0	+2 .3			
		+54	−0 .4	+2 .2	+0 .6	−2 .0			
		+55	0 .0	+4 .9	+0 .9	−0 .2			
		+56	+0 .3	−4 .3	−0 .5	+1 .4			
		+57	−2 .5	−0 .6	+0 .3	+0 .8			
		+58	+2 .4	0 .0	+0 .5	+0 .2			
		+59	+2 .0	0 .0	+0 .3	−0 .3			
		+60	−0 .9	−0 .1	−0 .2	−0 .1			
		+61	−0 .2	+0 .2	+0 .9	−1 .5			
		+62	+0 .9	+0 .9	+6 .1	−0 .3			
		+63	+1 .2	−0 .7	−1 .1	−0 .7			
		+64	+0 .3	+0 .2	−6 .0	−0 .5			
		+65	+0 .3	+0 .6	−0 .2	+0 .1			
		+66	+0 .9	+0 .1	−0 .1	+0 .2			
		+67	−0 .3	−0 .3	−0 .6	+1 .4			
Dover circle 177...	(*a*)		No. 2	No. 3	No. 5	No. 3 of 206	177.235(3)	−0′.5	In July 1916, because of unsatisfactory behavior, needles 1 and 6 were discarded and replaced by needles 3 of 177 and 3 of 206. Their corrections were deduced from an adjustment of the corrections for the common needles 2 and 5 over the range of inclination for which all 4 needles were used.
		+56°	−4′.3	+3′.0	−0′.5	+2′.2			
		+57	−0 .6	+2 .3	+0 .3	+1 .5			
		+58	0 .0	+1 .7	+0 .5	+0 .5			
		+59	0 .0	−0 .4	+0 .3	−1 .5			
Dover circle 177...	(*a*)		No. 2	No. 3	No. 5	No. 3 of 206	177.235(3)	....	For the period July 28 to Oct. 1916, after accident on July 27, 1916, when the instrument sustained a fall which bent the frame carrying the microscopes and caused other damage. The corrections applying after the accident were based on comparisons made in Oct. 1916 with circle 206 at Pehtaiho. The pivot of needle 5 was broken on Sept. 29, 1916.
		+56°	+2′.3	+3′.0	+2′.7	+3′.1			
		+57	+3 .7	+2 .8	+3 .0	+2 .8			
		+58	+2 .5	+3 .1	+3 .9	+2 .5			
		+59	+1 .7	+2 .5	+3 .8	+2 .8			
		+60	+3 .1	+2 .8	+3 .3	+3 .0			
		+62	+3 .2	+2 .8	+2 .9	+3 .1			
		+64	+2 .7	+1 .7	+2 .4	+3 .4			
		+66	+2 .3	+0 .7	+2 .5	+3 .0			
Dover circle 177...	(*a*)		No. 13X	No. 14X	No. 15X	No. 16X	177.4X or 177.2X(78) (See remarks)	−2′.3	Extensively overhauled, repaired, and readjusted between Oct. 1917 and Feb. 1919. Used during April 1919 in England and since May 1919 in equatorial Africa and Madagascar. In July 1920 the pivot of needle 16X was found to be loose; 15X, which showed poor behavior, and 16X were replaced in July 1920 by needles 7 and 8 of circle 242. Corrections for observed inclinations between −46° and −56° by needles 7 and 8 of circle 242, +3′.6 and −5′.0, respectively. The pivot of needle 13X was broken by a fall on Dec. 22, 1920; 15X was used in its place thereafter, its correction on standard for inclination −58° being +6′.0.
		+71°	−0′.3	−1′.4	+0′.2	0′.0			
		+67	−0 .3	−1 .4	+0 .2	−2 .8			
		+ 6	+0 .6	−0 .7	−1 .0	−0 .5			
		+ 4	+0 .7	−1 .0	+0 .7	−1 .8			
		+ 2	+0 .9	−0 .7	+0 .2	−2 .0			
		0	−0 .5	0 .0	−0 .6	−0 .5			
		− 2	−1 .0	+0 .7	−0 .8	−0 .5			
		− 4	−0 .2	+0 .5	−1 .1	−0 .8			
		− 6	0 .0	−0 .3	−0 .5	−0 .8			
		− 8	−1 .4	0 .0	+0 .5	−0 .7			
		−10	−0 .9	+0 .3	+0 .3	−1 .3			
		−12	−0 .2	0 .0	−0 .3	−1 .1			
		−14	0 .0	+0 .7	−1 .0	−1 .3			
		−16	+0 .1	+1 .0	−1 .5	−1 .2			
		−18	−0 .1	+0 .7	−1 .1	−1 .2			
		−20	−0 .3	+0 .4	−0 .3	+0 .2			
		−22	−0 .7	+0 .1	−0 .3	+2 .0			
		−32	−2 .8	+2 .5	−2 .0	+1 .1			
		−34	−2 .8	+3 .3	−1 .5	−0 .7			
		−36	−2 .8	+4 .0	0 .0	−2 .7			
		−38	−2 .8	+4 .6	+0 .9	−4 .7			
		−40	−2 .8	+5 .2	0 .0	−4 .0			
		−42	−2 .7	+5 .5	−1 .8	−2 .4			
		−44	−2 .7	+4 .7	−3 .7	+0 .1			
		−46	−2 .5	+3 .0	−4 .2	+3 .4			
		−48	−2 .1	+1 .2	−3 .4	....			
		−50	−1 .3	−0 .3	−2 .0	....			
		−52	−0 .4	+0 .2	....	....			
		−54	0 .0	+1 .1	....	....			
		−56	0 .0	+1 .1	....	....			
		−58	0 .0	+1 .1	....	....			

[1] For explanation of types, see p. 6.

TABLE 4.—*Inclination Corrections on Adopted International Magnetic Standard for the Period 1914–1920*—Continued.

Instrument	Type[1]	Inclination	Corrections for needle				Tabular designation	Correction for compass	Remarks
			No. 7						
Lloyd-Creak circle 189	(*b*)	+77° to +80°	+1′.9	....	....	....	189.7	+5′.1	Used during Aug. to Sept. 1914 at land stations in and about Reykjavik, Iceland, by *Carnegie* party. Needle 7 deflected by needle 8 short distance only; log *CdSt* = 9.4699 + 0.0001 (20° − *t*).
			No. 1	No. 2	No. 5	No. 6			
Lloyd-Creak circle 189	(*b*)	+66°.5	−4′.1	−1′.6	−20′.2	−5′.9	189.1256	....	Repaired and readjusted in Feb. 1915. Used during July 1915 for land observations at Dutch Harbor, Alaska, by *Carnegie* party.
			No. 1X	No. 2X	No. 3X	No. 4X			
Dover circle 201	(*a*)	−62°	+0′.4	−0′.6	+0′.4	−1′.0	201.(1234)	−5′.0	Used since May 1916 in New Zealand and Australia.
		−63	+0 .6	−0 .5	+0 .4	−1 .3			
		−64	−0 .5	−1 .3	+1 .1	−0 .1			
		−65	−1 .0	−1 .4	+0 .1	+1 .5			
		−66	−0 .8	−1 .3	+0 .1	+1 .2			
		−67	−0 .6	−1 .2	+0 .1	+0 .9			
		−68	−0 .3	−1 .1	0 .0	+0 .6			
			No. 1	No. 2	No. 5	No. 7			
Dover circle 202	(*a*)	+70°	−0′.5	−0′.2	+0′.4	+1′.1	202.1257	−13′.7	Used in field during Oct. 1913 to Dec. 1914 in Abyssinia and northern Africa.
		+60	−0 .2	−0 .4	+0 .2	−0 .3			
		+55	−0 .1	−0 .5	+0 .3	−0 .7			
		+50	−0 .1	−0 .8	+0 .5	−0 .7			
		+45	−0 .3	−1 .0	+0 .9	−0 .8			
		+40	−0 .5	−1 .0	+1 .2	−0 .7			
		+25	−0 .5	−0 .6	+0 .8	−0 .8			
		+20	−0 .5	−0 .4	+0 .6	−0 .8			
		+15	−0 .5	−0 .2	+0 .3	−0 .8			
		+10	−0 .5	0 .0	+0 .2	−0 .6			
		+ 5	−0 .6	+0 .2	+0 .1	−0 .4			
		0	−0 .6	+0 .4	−0 .1	0 .0			
		− 5	−0 .6	+0 .5	−0 .2	+0 .4			
		−10	−0 .6	+0 .6	−0 .3	+0 .8			
			No. 3	No. 4	No. 7X	No. 8X			
Dover circle 202	(*a*)	+70° to +71°	0′.0	0′.0	−0′.2	−0′.4	202.34(78)	−12.3	Subsequent to extensive overhauling and readjusting in July 1916. Used in field during July 1919 in United States.
			No. 1	No. 2	No. 5	No. 6			
Dover circle 205	(*a*)	+71° to +85°	−0′.7	−0′.2	−0′.1	−0′.4	205.1256	+4′.0	Instrument loaned during June 1913 to Dec. 1917 to Croker Land Expedition. Corrections for inclinations from needle 3 deflected by 4 and from 7 deflected by 8 in total-intensity work, −0′.2 and −1′.0; logarithms of total-intensity constant for needle-pairs 3 and 4, and 7 and 8, 9.57775 and 9.57626 (March 1913).
			No. 1	No. 2	No. 5	No. 6			
Dover circle 205[2]	(*a*)	+71° to +86°	−0′.2	−0′.4	−0′.1	−0′.3	205.1256	−2′.2	Used since Aug. 1918 by the *Maud* Expedition of Captain Roald Amundsen. Corrections for inclinations from needles 3 deflected by 4 and from 7 deflected by 8 in total-intensity work, −0′.9 and −2′.1; logarithms of total-intensity constant for needle-pairs 3 and 4, and 7 and 8, 9.57770 and 9.57594 (April 1918).

[1] For explanation of types, see p. 6.
[2] Extensively modified for use in Arctic work, overhauled, and readjusted during April to May 1918.

TABLE 4.—*Inclination Corrections on Adopted International Magnetic Standard for the Period 1914–1920*—Continued.

Instrument	Type[1]	Inclination	Corrections for needle				Tabular designation	Correction for compass	Remarks
			No. 1	No. 2	No. 5 of 178	No. 6 of 178			
Dover circle 206...	(*a*)	+31°	−5′.6	−0′.9	+4′.1	−3′.7	206.12(56)	+0′.3	Used in field during Aug. 1914 to Feb. 1918 in China and India (stored in China and not in use from Feb. 1912 to Aug. 1914). The data for needles 5 and 6 of 178 show large pivot irregularities. There is evidence that changes took place in the corrections during the interval of field use, but the data are too meager to determine such time changes.
		+33	−3 .1	−1 .3	+1 .1	−2 .5			
		+35	−0 .8	+1 .0	−1 .0	−1 .5			
		+37	−2 .2	0 .0	+0 .5	−1 .2			
		+39	0 .0	+1 .1	+1 .0	−3 .0			
		+41	+2 .0	+3 .2	+0 .3	−5 .1			
		+43	+1 .2	+2 .0	+2 .8	−5 .5			
		+45	+0 .5	+0 .7	+6 .2	−4 .3			
		+47	+2 .1	+2 .4	−0 .3	−0 .8			
		+49	+1 .0	+1 .2	+1 .3	−0 .6			
		+51	+1 .1	+1 .8	+1 .1	−1 .7			
		+53	+1 .5	+2 .7	+1 .0	−1 .9			
		+55	+0 .8	+1 .4	+2 .0	−0 .9			
		+57	+0 .3	+1 .0	+2 .5	+0 .2			
		+59	+0 .8	+1 .8	+0 .8	+0 .5			
		+60	+1 .3	+2 .2	0 .0	+0 .4			
		+71	−0 .3	+0 .2	+5 .8	−0 .8			
			No. 5	No. 6	No. 11X	No. 12X			
Dover circle 206...	(*a*)	+62° to +71°	0′.0	+1′.4	+0′.6	+0′.6	206.56(2X)	−6′.9	Subsequent to extensive overhauling and readjusting in May 1918. Used in field during June 1918 in United States.
			No. 1	No. 2	No. 5	No. 6			
Dover circle 222...	(*a*)	+70°	+0′.2	0′.0	−0′.4	+0′.6	222.1256	+2′.8	Minor repairs in Jan. 1914. Used during Feb. 1914 to June 1915 in Canary Islands and equatorial Africa.
		+50	−0 .4	+1 .0	−0 .6	+0 .4			
		0	0 .0	+1 .8	−0 .5	−0 .8			
		− 5	0 .0	+1 .5	−0 .5	−0 .8			
		−10	+0 .1	+1 .2	−0 .4	−0 .7			
		−15	+0 .2	+0 .8	−0 .4	−0 .4			
		−20	+0 .3	+0 .4	−0 .4	−0 .2			
		−25	+0 .4	+0 .1	−0 .5	−0 .3			
		−30	0 .0	+1 .3	−0 .4	−0 .6			
		−35	+0 .5	+0 .5	+0 .7	−1 .4			
		−40	+0 .7	−0 .5	+1 .1	−1 .1			
		−45	−0 .6	−0 .8	+2 .0	−0 .5			
			No. 1	No. 3	No. 5	No. 6			
Dover circle 223...	(*a*)	+70°	−0′.4	+0′.2	−1′.2	−0′.2	223.1356	+3′.0	Subsequent to overhauling and readjusting in May 1914. Used during Dec. 1915 to Dec. 1918 in New Zealand, Australia, Africa, Egypt, Arabia, Ceylon, and Japan. Needle 5 was somewhat erratic in behavior and, therefore, has been combined in taking means with the other needles with a weight of one-half.
		+50	−0 .6	+0 .2	−2 .4	0 .0			
		+40	−0 .6	+0 .2	−2 .5	0 .0			
		+30	−0 .5	+0 .2	−1 .8	−0 .1			
		+20	−0 .3	+0 .2	−1 .1	−0 .2			
		+10	−0 .1	+0 .3	−0 .6	−0 .5			
		0	−0 .1	+0 .2	−0 .4	−0 .6			
		−10	0 .0	+0 .1	−0 .4	−0 .6			
		−20	+0 .1	+0 .1	−0 .5	−0 .7			
		−30	+0 .2	+0 .1	−0 .5	−0 .6			
		−40	+0 .3	0 .0	−0 .8	−0 .7			
		−50	+0 .4	−0 .1	−1 .3	−0 .8			
		−60	+0 .5	−0 .1	−1 .9	−0 .8			
			No. 1	No. 2					
Dover circle 226...	(*a*)	−65° to −68°	+0′.4	+0′.4	....	....	226.12	....	Property of the South Australian Government Observatory. Used during Sept. 1915 to Feb. 1918 in South Australia.
			No. 1	No. 2	No. 5	No. 6			
Dover circle 242...	(*a*)	+71°	+1′.6	+1′.2	−1′.0	+0′.3	242.1256	−1′.3	Used during Feb. to Oct. 1919 in South America.
		−15	−1. 8	−1 .0	+5 .2	−0 .4			
		−20	−2 .3	−0 .8	+5 .5	−0 .4			
		−25	−2 .7	−0 .6	+5 .7	−0 .4			
		−30	−3 .0	−0 .4	+5 .8	−0 .4			
		−35	−2 .8	+0 .1	+5 .6	−0 .9			
		−40	−2 .8	+0 .5	+5 .1	−0 .9			
		−45	−3 .9	+0 .6	+5 .7	−0 .4			
		−50	−3 .0	+0 .3	+5 .5	−0 .8			

[1] For explanation of types, see p. 6.

TABLE 4.—*Inclination Corrections on Adopted International Magnetic Standard for the Period 1914–1920*—Concluded.

Instrument	Type[1]	Inclination	Corrections for needle				Tabular designation	Correction for compass	Remarks
			No. 1X	No. 2X					
Casella circle 4655.	(*a*)	+71° to +87°	+0′.5	−0′.6	....	....	4655.(127) (See remarks)	−1′.1[2]	Property of United States Coast and Geodetic Survey. Used during June to Oct. 1914 in Canada and Labrador. Correction for needle 7 deflected by needle 8 of circle 201 in total-intensity work for dips +76° to +77° was −1′.1; logarithm of total-intensity constant[3] for needle-pair 7 and 8 of 201 was 9.56407.
Earth inductor 2..	[4]	All values	0′.0	....	....	....	EI 2	....	Used since July 1916 in Australia.
Earth inductor 3..	[5]	All values	−0′.6	....	....	....	EI 3	....	Used since June 1914 on cruises of *Carnegie*.
Earth inductor 4..	......	All values	+0′.3	....	....	....	EI 4		Used since 1913 at Mauritius Observatory. Marine type, made by Department of Terrestrial Magnetism, adapted for land use.
Earth inductor 5..	[4]	All values	0′.0	....	....	....	EI 5	....	Used during Sept. 1916 to Sept. 1917 and since Feb. 1919 in South America, and during May to June 1918 in United States.
Earth inductor 6A.	[6]	All values	−0′.5	....	....	....	EI 6A	....	Property of Captain Roald Amundsen.
Earth inductor 7..	[5]	All values	−0′.1	....	....	......	EI 7	....	Used since Oct. 1919 on cruise of *Carnegie*.
Earth inductor 48[7].	[6]	All values	0′.0	....	....	....	EI 48	....	Standard instrument of the Department since 1907.
Magnetometer inductor 24.......	4(*c*)	All values	−0′.3	....	....	....	EI 24	....	Used during Jan. 1914 to Feb. 1915 in Australia, during July 1917 to July 1918 in China, and during May to July 1919 in Africa.
Magnetometer inductor 25.......	4(*c*)	All values	0′.0	....	....	....	EI 25	....	Used for land work on cruises of *Carnegie* during June 1914 to June 1918 (including extended field work in South America during May to Nov. 1917) and since Sept. 1919, and during June to July 1919 in United States.
Magnetometer inductor 26.......	4(*c*)	All values	−0′.1	....	....	....	EI 26	....	Used during June 1915, Sept. to Nov. 1917, May to June 1918 in United States, and during July 1915 to March 1916 in Europe.
Magnetometer inductor 27.......	4(*c*)	All values	−0′.1	....	....	....	EI 27	....	No field use.
Magnetometer inductor 28.......	4(*c*)	All values	−0′.2	....	....	....	EI 28	....	Used during Jan. to Aug. 1917, and March to Aug. 1919 in South America.

[1] For explanation of types, see p. 6.

[2] Compass attachment of circle 201 was used with circle 4655 during June to October, 1914.

[3] After the breaking of pivot of needle 8 of circle 201 on October 8, 1914, only deflection observations were possible; the logarithm of the total-intensity deflected-dip constant used for the few stations following was 9.45415 at 20° C., using the effect of temperature coefficient on the logarithm as an increase of 0.00010 for a decrease of 1° C.

[4] Wild-Eschenhagen type, as made by Toepfer and Son, with Department modifications.

[5] Marine type, made by the Department of Terrestrial Magnetism.

[6] Wild-Eschenhagen type, as made by Schulze.

[7] Designated by maker's number; this instrument is serial number 1 of the Department.

EXPLANATORY REMARKS.

Precisely the same conventions have been followed in the presentation of the field results obtained during the seven years 1914 to 1920 as adopted in Volumes I and II. These conventions, briefly recapitulated, are as given in the following paragraphs.

It has not been deemed advisable to attempt at present to apply corrections to the observed results on account of the numerous variations of the Earth's magnetism, *e. g.*, diurnal variation, secular variation, magnetic perturbations, etc. Instead, it is believed to be better to publish the observed results as obtained, with no corrections applied except the reductions to the magnetic standards of the Department, as fully explained in the section on this subject; thus undue delay is avoided in the promulgation of the results. The reduction to a common epoch can be undertaken more advantageously later. It will be noticed, however, that opposite the magnetic elements appearing in the Table of Results, the precise date and local mean time of each observation are given. The reader is thus supplied with the required information in case he may find it necessary to reduce the observed values to some mean time.

The following main geographic divisions have been adopted: Africa, Asia, Australasia, Europe, North America, South America, Islands Atlantic Ocean, Islands Indian Ocean, and Islands Pacific Ocean. Under each main division there are broad subdivisions (see Africa, for example). The tabular entries under these subdivisions are in the order of decreasing north or increasing south latitude; that is to say, in the order of increasing colatitude counting from the North Pole to the South. When there are stations of the same latitude, their order is according to increasing east longitude, counting continuously from the standard meridian of Greenwich, or from zero to 360 degrees.

The question whether to give values of the horizontal intensity, exclusively, or values of total intensity, was decided, for practical reasons, in favor of the former. In the vast majority of cases, the horizontal intensity rather than the total is observed, and most likely will continue to be for some years at least. Only in high magnetic latitudes, where the horizontal intensity is small and hence its observation more or less difficult, are total intensities generally obtained. Rather than give total intensities, as derived by computation with the aid of the observed horizontal intensity and inclination, it was thought a better procedure to compute, in the considerably smaller number of cases, the horizontal intensity from the observed total-intensity and inclination, the so-obtained values being italicized in order to reveal their derivation.

It was also decided to publish the intensities in C.G.S. units.[1] In magnetic-survey work on land the fourth decimal is often uncertain by one or more units and

[1] The capital gamma, Γ, was used in Volumes I and II to designate a C.G.S. unit of magnetic intensity; but as it is not generally used for this purpose, its use by us was discontinued beginning with Volume III.—L. A. B.

in ocean work the error may be five or more units in this decimal place. For these reasons it appears inadvisable for field results to adopt so small a unit as a small gamma, $\gamma = 10^{-5}$ C.G.S. unit; it would be necessary otherwise at times to round out the observed value by one or more zeros. If the conditions under which an intensity result was obtained were such as not to warrant publishing the fourth or fifth decimal, this is shown by stopping with the decimal deemed certain. In general, however, as will be seen, the value to the fifth decimal is given, but it should be understood that no claim is made as to the correctness of the last figure; it has been retained here primarily in order that when all reductions to common epoch have been applied on account of the magnetic variations, an error of a unit in the fourth decimal, due purely to computation, will not enter.

The first column in the table is headed "Station"; this gives the name of place at which the magnetic elements were observed, the spelling adopted being in accordance with the most reliable information at hand and conforming as far as possible to local usage. The next column gives the geographical position, latitudes, and longitudes, as derived in most cases from the observers' local astronomical observations following the methods already described in Volumes I, II, and III (see also pages 23–29). When the latitudes are the results of fairly complete circummeridian observations of the Sun, or the means of several reoccupations of the same station, or are derived from reliable large-scale maps, then they are given to the nearest $0'.1$, though it should be distinctly understood that this accuracy is not guaranteed, as even for these cases the error may be as much as $0'.5$, and even in some instances a whole minute of arc. When the latitudes are given only to the nearest minute, there were either no astronomical determinations, or they may have been incomplete or defective; these values are usually taken from standard atlases and for some regions may be in error by several minutes. Owing to the numerous sources of error of a longitude determination, and especially because of the uncertainty in more or less unexplored countries of the adopted chronometer-correction on standard time, the longitude in no instance is tabulated closer than to the nearest minute of arc. Usually it is derived from the observers' astronomical observations. Considerable use was also made of reliable large-scale maps, whenever available, and of standard atlases; the values in regions but slightly surveyed may be out sometimes by several minutes (see pages 23–25).

The date on which the magnetic observations were made will be found in the fourth column. The following abbreviations have been adopted for the months of the year: Jan, Feb, Mar, Apr, May, Jun, Jul, Aug, Sep, Oct, Nov, Dec. The values of the magnetic elements will be found in the next columns as observed at the local mean time, expressed to nearest 0.1 of an hour, opposite each value. Occasionally it has appeared desirable, where diurnal variation in declination was observed or where numerous observations were made during a limited interval, to give the local mean times of the beginning and of the end of the series and to indicate the number of determinations from which the mean value is derived by a number inclosed in parentheses: thus $9^h.1$ to $11^h.3$(7) is to be read "the mean

is the result of seven determinations made during the interval $9^h.1$ to $11^h.3$, local mean time, inclusive"; $6^h.1$ to $20^h.3$(dv) is to be read "eye readings of the suspended magnet were made regularly at short intervals from $6^h.1$ to $20^h.3$, local mean time." For observatories and other fixed stations, where observations were made frequently, it has appeared desirable to give only the mean values of the magnetic elements as determined at approximately the same local mean times on each of the days grouped in the date column (see entries for Watheroo Observatory and footnote, p. 57). The local mean times are given according to civil reckoning and are counted from midnight as zero hour continuously through 24 hours; 16^h, for example, means 4 o'clock p. m.

The declination values, as also of inclination, are in general given in degrees, minutes, and tenths of minute of arc. For instruments which are not regarded as capable of yielding great accuracy only the nearest minute is given. The tabulation of values of the horizontal intensity has already been explained above.

The instruments used are shown in the columns "Mag'r" (magnetometer) and "Dip Circle." When the number of an instrument in magnetometer column is italicized, it means that a dip circle has been used in getting the declination by means of the compass attachment, and that total instead of horizontal intensity was observed. A designation in the column Dip Circle, *e. g.*, 206.12, stands for "Dip circle No. 206, needles Nos. 1 and 2"; 222.1256, for "Dip circle No. 222, needles Nos. 1, 2, 5, 6"; 171.12(78) for "Dip circle No. 171, needles Nos. 1 and 2 of No. 171 and 7 and 8 of another circle," as explained in Table 4, giving "Inclination Corrections."

OBSERVERS.

In the last column of the Table of Results, the observer responsible for the observations is shown by his initials. Those engaged from time to time in the execution of the present work were as given in Table 5.

When observations were made jointly by two observers, this fact is shown by the combination of their last initials, as indicated in the latter part of Table 5.

For the land observations secured by members of the ocean party the abbreviations C III, C IV, C V, and C VI have been used for the various cruises of the *Carnegie*. Observers on the cruises for which this volume contains results were as follows:

C III: J. P. Ault, commander; with Observers H. M. W. Edmonds, H. F. Johnston, I. A. Luke, and N. Meisenhelter.

C IV: J. P. Ault, commander; with Observers H. M. W. Edmonds, H. F. Johnston (to April 1916), I. A. Luke (to October 1916), H. E. Sawyer (from April to November 1916), N. Meisenhelter, F. C. Loring (to October 1916), B. Jones (from April 1916), A. D. Power (from November 1916), and L. L. Tanguy (from November 1916).

C V: H. M. W. Edmonds, commander; with Observers A. D. Power, B. Jones, L. L. Tanguy, J. M. McFadden, and W. E. Scott.

C VI: J. P. Ault, commander; with Observers H. F. Johnston, R. Pemberton, A. Thomson, H. R. Grummann, and R. R. Mills.

TABLE 5.—*Land Magnetic Observers, 1914–1920.*

Observer	Designation	Observer	Designation	Observer	Designation
R. Amundsen[1]	RA	W. J. Peters	WJP	Fisk, Grummann, and Mills	F, G, M
J. P. Ault	JPA	A. D. Power	ADP	Fisk and Kidson	F&K
L. A. Bauer	LAB	H. E. Sawyer	HES	Fisk and Mills	F&M
D. W. Berky	DWB	H. R. Schmitt	HRS	Fisk and Wise	W&F
F. Brown	FB	A. Sterling	AS	Fleming and Wise	F&W
G. F. Dodwell[2]	GFD	H. U. Sverdrup[1]	HUS	Grant and Burdon[2]	G&B
C. R. Duvall	CRD	L. L. Tanguy	LLT	Grummann and Mills	G&M
H. M. W. Edmonds	HME	A. Thomson	AT	Kidson and Brown	K&B
C. K. Edmunds	CKE	W. F. Wallis	WFW	Kidson and Kennedy	K&K
C. C. Ennis	CCE	D. M. Wise	DMW	Kidson and Parkinson	K&P
H. W. Fisk	HWF	O. Wisting[1]	OW	Kidson, Parkinson, and Kennedy	K, P, K
J. A. Fleming	JAF	Ault, Fisk, and Thomson	A, F, T	Johnston and Mills	J&M
H. R. Grummann	HRG	Ault and Power	A&P	Luke, Berky, and Sawyer	L, B, S
H. Hansen[1]	HH	Ault and Thomson	A&T	Parkinson and Kennedy	P&K
C. W. Hewlett	CWH	Bauer and Johnston	B&J	Parkinson and Ross[7]	P&R
G. L. Hosmer[3]	GLH	Bauer, Sutton, and Elder[6]	B, S, E	Peters and Ault	P&A
Ip N. K.[4]	INK	Brown and Ip	B&I	Peters and Berky	P&B
H. F. Johnston	HFJ	Dodwell and Grant[2]	D&G	Peters and Fisk	P&F
B. Jones	BJ	Edmonds and Johnston	E&J	Power and Tanguy	P&T
A. L. Kennedy	ALK	Edmonds and Kidson	E&K	Schmitt and Sterling	S&S
E. Kidson	EK	Edmonds and Rosemberg	E&R	Schmitt and Tanguy	S&T
J. M. Kuehne[5]	JMK	Edmunds and Brown	E&B	Wallis and Parkinson	W&P
I. A. Luke	IAL	Edmunds and Ip	E&I	Wise and Jones	W&J
J. M. McFadden	JMM	Fisk and Berky	F&B	Wise and Sterling	W&S
R. R. Mills	RRM	Fisk and Ennis	F&E	Wise and Thomson	W&T
W. C. Parkinson	WCP	Fisk and Grummann	F&G		

[1] Observers of the "*Maud* Expedition" (Amundsen Arctic Expedition).
[2] Messrs. G. F. Dodwell, Kerr Grant, and R. S. Burdon of the Adelaide Observatory, South Australia.
[3] Of the Massachusetts Institute of Technology, Cambridge, Mass. [4] Chinese assistant observer.
[5] Of the University of Texas, Austin, Texas.
[6] Messrs. R. Sutton and E. Waite Elder of the East End High School, Denver, Colorado.
[7] Professor A. D. Ross of the University of Western Australia, Perth, Western Australia.

The original computations of observations are all made by the observers themselves in the field. The observers have also frequently taken part in making the final office-computations of one another's observations, but the chief burden of the final computations has been borne by the following members of the office personnel: J. P. Ault, C. R. Duvall, H. M. W. Edmonds, C. C. Ennis, H. W. Fisk, J. A. Fleming, W. J. Peters, M. B. Smith, and Emma L. Tibbetts. Mention should also be made of the efficient services rendered by the instrument-makers of the Department in the construction and repair of field instruments and accessories.

DISTRIBUTION OF STATIONS.

Some idea of the extent of the land work represented in the Table of Results may be obtained from the synopsis given in Table 6, showing the geographical distribution of the stations occupied during the seven years 1914 to 1920. Data have been secured on every continent, as also on numerous islands in the Atlantic, Indian, and Pacific Oceans, and, in cooperation with the "*Maud* Expedition" (Captain Amundsen's Arctic Expedition). The work has been done chiefly in Australasia, South America, and Africa. The stations occupied during the seven years, as shown in Table 6, total 1,747 (1,661 primary and 86 secondary), an average of about 250 per year. Of the primary stations, there are about 82 at which the full program (declination, inclination, and intensity), for some reason,

could not be carried out, the data for some one element being in consequence lacking. Practically all of the secondary stations lack two of the magnetic elements, either because they were generally established merely for investigating the possible existence of local disturbance, or because the time available was insufficient for complete observations.

Of the 204 "C.I.W. repeat localities" listed in Table 6, which furnish secular-variation data for localities previously visited by observers of the Department of Terrestrial Magnetism, the reoccupations for each locality listed involve from 1 to 4 stations and may be classified as follows: exact, 94; close, *i. e.*, within less than 30 meters, 74; practical, *i. e.*, within less than 300 meters, 18; and proximate, *i. e.*, within less than 5 kilometers, 18. For many of these localities the repeat observations have been obtained not only at several stations, but also at different times during 1914 to 1920. Furthermore, fully 150 of the stations were points at which the magnetic elements had been determined previously by other organizations or observers; about one-half of these were reoccupations within 300 meters and the remainder within 5 kilometers. Thus secular-variation and correlation material result from over 20 per cent of the data given in the present volume. The stations include those occupied for intercomparison observations at 17 magnetic observatories; several of these have been occupied more than once, thus affording further data regarding the question as to the degree of accuracy within which the instrumental constants can be maintained under strenuous field conditions. The results of the comparisons of magnetic standards made at these observatories will be given in a later special report.

The Department of Terrestrial Magnetism has continued to furnish instrumental and other assistance in cooperating with various organizations. The "*Maud* Expedition" of Captain Roald Amundsen, begun in 1918, was supplied with a complete magnetic outfit, including specially adapted magnetometer and dip circle (see page 8 and Plate 2), accessories, instrumental constants, and detailed instructions for proposed work. There has thus already been obtained the valuable series of observations along the north coast of Siberia to be found in the Table of Results. The Department likewise has loaned a magnetometer to Government-Astronomer G. F. Dodwell of South Australia; Mr. Dodwell and his assistants have observed at numerous stations in South Australia, the data obtained being given in the Table of Results. Extensive cooperative work in connection with special observations, as, for example, during solar eclipses, has also been accomplished.

CONCERNING GEOGRAPHIC POSITIONS.

Full use in theoretical discussions of accurate magnetic observations requires that the geographic coordinates of stations be known with a fair degree of accuracy (see Volume I, pp. 22 *et seq.*). The determination of latitude is comparatively simple, and in general, as already stated for the methods followed (see p. 5), the error in this coordinate is usually less than 0′.5, and usually within about 0′.2. The determination of longitude, on the other hand, is subject to a greater uncertainty.

TABLE 6.—*Summary Showing the Geographical Distribution of Magnetic Stations, 1914–1920.*

Countries and subdivisions	No. of stations		C. I. W. repeat localities[1]	Totals by country
	Primary	Secondary		
Africa				447
Abyssinia	17		1	
Anglo-Egyptian Sudan	48		1	
Angola	45		9	
Belgian Congo	62		9	
British South and Central Africa	16		4	
Cameroun	42		4	
Cyrenaica	5			
Egypt	17	1	4	
Eritrea	4		2	
French Equatorial Africa	104	1	4	
French Somaliland	1		1	
French West Africa	7		1	
Gold Coast Colony	8	1	2	
Liberia	3		1	
Nigeria	30		1	
Portuguese East Africa (Mozambique)	19	2	3	
Southwest Africa	6		6	
Spanish Guinea	3			
Tripolitania	3		1	
Uganda	2		1	
Asia				356
Arabia	2		2	
China	337	11	30	
India	2			
Japan	1		1	
Siberia	1			
Straits Settlements	2		1	
Australasia				315
Australia	272	26	30	
New Zealand	16	1	1	
Europe				24
Great Britain	9	6	2	
Norway	7			
Russia	2			
North America				113
Canada	8		1	
Central America	5		3	
Newfoundland (Labrador)	23	2	2	
United States[2]	65	10	7	
South America				339
Argentina	76	1	6	
Bolivia	32		4	
Brazil	106	5	10	
Chile	26	1	8	
Colombia	19		3	
Ecuador	3		3	
Guiana	4	1	4	
Peru	49	6	14	
Uruguay	1		1	
Venezuela	9		2	
Islands Atlantic Ocean				19
Canary Islands	2		2	
Fernando Po	1			
Iceland	9			
Madeiras	2		1	
St. Helena	1		1	
South Georgia Island	1			
West Indies	3		3	
Islands Indian Ocean				30
Ceylon	2		1	
Madagascar	28			
Islands Pacific Ocean				104
Bismarck Archipelago	1			
Easter Island	1			
Ellice Islands	9			
Fiji Islands	1		1	
Gilbert Islands	11			
Hawaiian Islands	3		1	
Lord Howe Island	1			
Marianas (Ladrone Islands)	4		1	
New Caledonia (Loyalty Islands)	7	1		
New Guinea and Islands	20	3		
New Hebrides	8	3		
Norfolk Island	1			
Samoan Islands	3		2	
Society Islands	8	2	1	
Solomon Islands	9	2		
Tokelau Islands	3			
Tonga Islands	3			
Grand total				1747

[1] The actual number of reoccupied stations is considerably greater than enumerated since repeat stations close together are counted as one locality and reoccupations of the same station at different times during 1914 to 1920 are counted but once.

[2] Including stations in the Standardizing Magnetic Observatory of the Department of Terrestrial Magnetism at Washington; only the results with standard instruments (magnetometer C. I. W. No. 3 and earth-inductor C. I. W. No. 48) in connection with the determinations of constants and the standardization of instruments are given.

The methods of determining longitude which are possible for observers traveling under the conditions imposed by the requirements of the Department's work, depend upon: (*a*) time-control by telegraph or cable connection with sources of reliable time-signals; (*b*) time-control by means of radio equipment sufficient for receiving time-signals from high-power stations; (*c*) transporting time by means of chronometers, or by means

of three or more high-grade watches; (*d*) observations of occultations or of eclipses of the moons of Jupiter; and (*e*) utilization of data from reliable maps and previous surveys.

At all stations, unless prevented by lack of time or by cloudy weather, observations on the Sun, or on a star, are made to obtain the correction of the time-piece on local mean time. For most of the work done, it is not possible to exercise time-control by method (*a*). The question of a suitable radio-outfit (method *b*) has received consideration with respect to the special needs of the more recent expeditions. On a few expeditions a box chronometer has been carried, but with unsatisfactory results, owing to the difficulties of the methods of transportation available. Night work, such as required by (*d*), is usually objectionable, especially in the tropical regions, where much of the Department's work has been done, on account of risk to the observer's health and to the success of the expedition. Since, furthermore, the observations by (*d*) are long and troublesome to reduce, and can only be made at predicted times, without opportunity for desired repetitions and checks, no very serious attempts have been made to use occultations, or similar astronomical methods, for the determination of longitude. Some regions are so well mapped that the required longitudes may be scaled from the maps with sufficient accuracy; thus, for the extensive work in Australia, satisfactory geographic positions could be obtained with the aid of the excellent system of surveys covering most of that country.

After careful study of the conditions and of the experiences gained on numerous expeditions, transporting time by means of three or more watches, has been the method generally adopted and in many cases has given very good results. The best of watches, however, for one reason or another, often become unreliable when subjected to the trying conditions of a field expedition extending over several months. In such cases, the longitudes of the most important points as obtained from the best available sources are accepted, and the intermediate positions are derived, with the aid of the determined watch-rates, by interpolation.

In order to keep the watches at a fairly constant temperature, the observer during the day usually carries them in a belt on his person. He keeps them upright during the night, winding them daily at about the same time, and comparing them with each other morning and evening and whenever necessary for control. With not less than three good time-pieces thus treated, consistent longitudes have been derived in regions where no good values were otherwise available. The experiences, for various reasons, have been unsatisfactory when the attempt was made to use a least-square formula for reducing the results from the individual time-pieces.

It is recognized that all time-pieces of a set may be affected alike when subjected to identical treatment, *e. g.*, to the same changes in temperature and to the same vicissitudes of transportation. They may all run faster or all run slower, and no method of determining a rate from comparisons between them will serve to detect that fact. Using watches of different sizes, different makes, and varying adjustments reduces the error apppreciably but does not eliminate it.

In general, a careful analysis of the performance of the time-pieces as shown by the daily comparisons and the observations for local time will, for short expeditions, so control obvious changes in mean rate and occasional abrupt changes that watch-corrections on standard time may be derived which will serve the purpose for which the observations are made, though falling short of the accuracy desired by the geographer. For such expeditions the maximum error is often apparently kept within 5 to 8 seconds, though it will doubtless largely exceed this under unfavorable conditions. It may be of interest to note that the best maps available for many of the regions traversed by our observers have been found in error in remote places by as much as one-half degree, corresponding to 2 minutes of time.

REVISIONS OF FIELD COMPUTATIONS.

ASTRONOMICAL WORK.

The astronomical observations necessary for determination of geographic position and of the true azimuth of a line of reference at a magnetic station are computed in the field by the observers of the Department before the records are transmitted. These field computations are later revised at the office in Washington, where corrections demanded by any obvious error in the original work are applied, and also refinements are made arising from considerations such as a better determination of atmospheric refraction or of chronometer rate. *Changes in latitude* are frequently made in these revisions, and it is desirable to correct for the effects of such changes in azimuth of the reference lines or in the chronometer corrections on local mean time and consequent longitude determinations, without making an entire recomputation. This may be done with sufficient accuracy for the purpose by using differential formulæ involving azimuth, A, latitude, φ, and hour-angle, t, thus[1]:

$$\frac{dA}{d\varphi} = -\sec\varphi \cot t \qquad (1)$$

$$\frac{dt}{d\varphi} = -\sec\varphi \cot A \qquad (2)$$

Since the changes in latitude for which corrections must be made are relatively small, usually not more than one minute of arc, and since the accuracy demanded in the resulting true azimuth is on the order of one-tenth of a minute of arc with a larger permissible range in hour-angle, the requirements of the problem may be sufficiently met by using graphs of the values of the quantities, given by the formulæ. The formulæ (1) and (2) being identical but for the interchange of the symbols representing azimuth and hour-angle, one system of curves will serve for both quantities.

The derivatives in the form adopted above are functions of two variables, and a family of curves is required to fully represent the series. The loci for like values of the correction-factors when $d\varphi = 1$ minute of arc for different values of φ and A or of φ and t may be readily determined from the above equations. By suitably selecting the factors to be plotted a graphical chart of correction-curves is obtained from which corrections of requisite accuracy may be easily noted. Figure 1 gives such a chart.

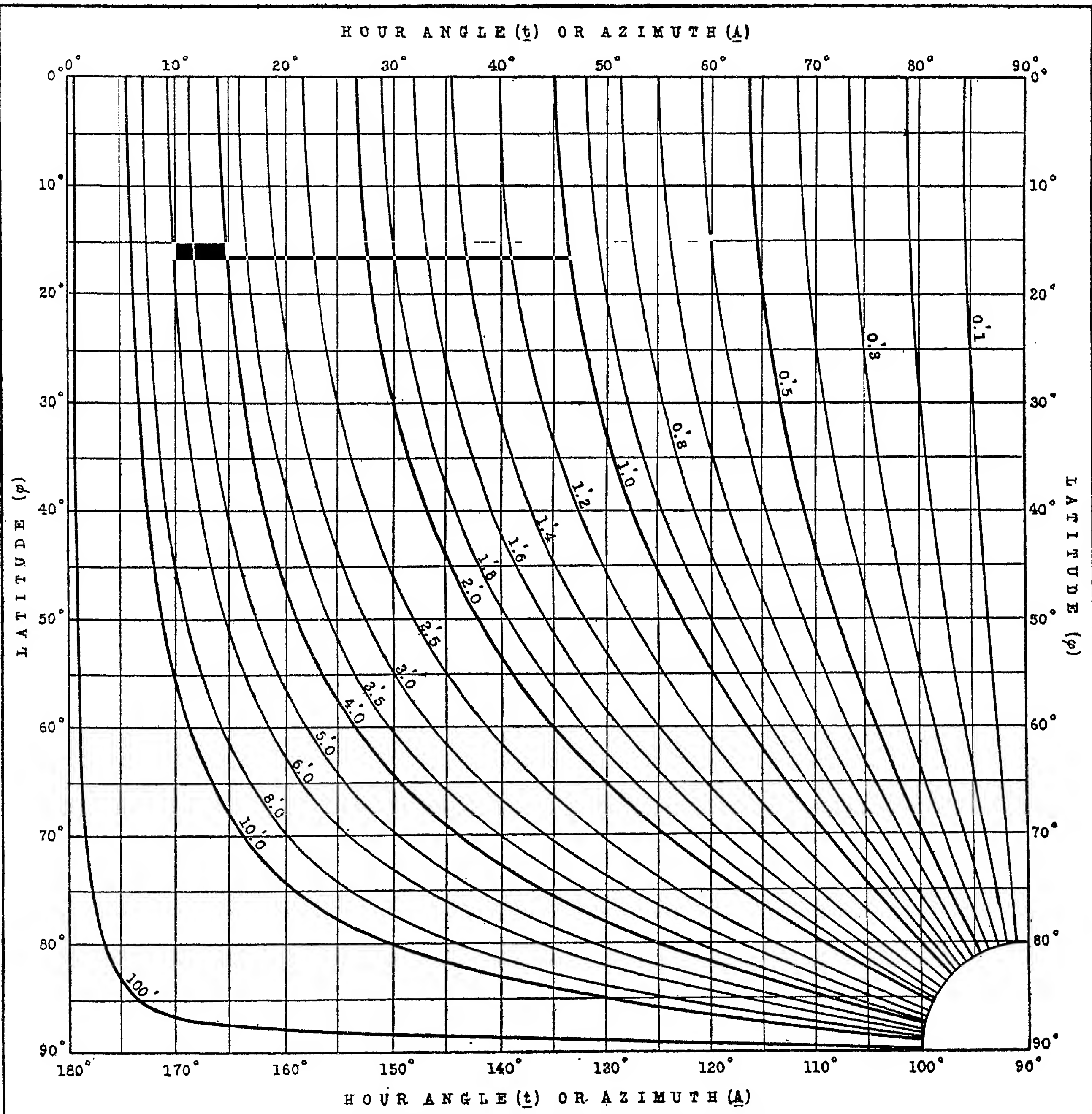
To determine the *change in the azimuth* arising from a given change in latitude, the computer has only to locate the point on the graph corresponding to the approximate latitude of the station for the approximate hour-angle of the celestial body as shown by the original computation, to estimate from the adjacent curves the value of the correction-factor, and to multiply the given change in latitude expressed in minutes by this factor. The change in the chronometer correction on local mean time is obtained in the same way, but by using the azimuth of the body instead of the hour-angle. The change in the coefficient from one locus to the following is not linear, but within the limits laid down no appreciable error will arise from so regarding it.

To apply properly the corrections obtained by use of the graph, it is necessary to give attention to the sign. It is convenient to modify the usual convention in this case, and instead of counting continuously around through 360° from the meridian, to regard the azimuth or hour-angle of a body west of the meridian as positive, and when east of the meridian as negative, thus avoiding the danger of confusion of sign arising from using angles greater than 180°. The factor $\sec\varphi$ is always positive since latitude cannot exceed 90°, and consequently the sign of the correction factor will depend upon that of $\cot t$ or of $\cot A$.

[1] *Cf.* Comstock, G. C., Astronomy for Engineers, p. 207.

FIG. 1.—*Effect of change of one minute of arc in latitude on azimuth of mark or on correction on local mean time.*

[Formulae: $dA = -\sec\phi \cdot \cot t \cdot d\phi$; $dt = -\sec\phi \cdot \cot A \cdot d\phi$]



RULES FOR APPLYING CORRECTIONS

Latitude change toward	If sun's or star's hour-angle is	When observed body is East — Azimuth of mark will	When observed body is West — Azimuth of mark will	If sun's or star's azimuth is	When observed body is East — Correction on L.M.T. will	When observed body is West — Correction on L.M.T. will
North	Less than 90°	Increase	Decrease	Less than 90°	Increase	Decrease
	Greater than 90°	Decrease	Increase	Greater than 90°	Decrease	Increase
South	Less than 90°	Decrease	Increase	Less than 90°	Decrease	Increase
	Greater than 90°	Increase	Decrease	Greater than 90°	Increase	Decrease

The corrections obtained by use of the graph are applicable immediately to the azimuth or to the hour-angle of the observed body, but by proper consideration of the subsequent steps in the reductioons, they may as well be applied at once to the ultimate objects of the computation, *viz*, to the azimuth of the reference mark or to the correction of the chronometer on local mean time. The rules given of the bottom of Figure 1 have been made to meet this requirement.

MAGNETIC WORK.

The determination of horizontal intensity at a field station with the magnetometer involves measuring the period of one oscillation of the magnet by direct observation. When the chronometer used has other than a zero rate, the observed period of one oscillation must be corrected for error caused by the rate of the chronometer. An observer traveling in unmapped or poorly mapped regions, pending the discussion of his time observations upon the conclusion of the expedition, has generally only an approximation to the true rate, and he is, therefore, obliged to make his computation using a zero or an approximate rate; the correction for rate as finally adopted has then to be applied when the office revisions are made.

It is usually expedient to defer the decision as to the rate until the completion of the expedition, when the observer has made his final report and has submitted all information relating to geographical position such as maps and results of local surveys obtained in the field. The adjustment from this material is often a troublesome process involving considerable time and requiring careful analysis. In order that the revision of the observer's results may not be delayed because of this work, it has been found practicable to apply the necessary corrections on account of the finally adopted chronometer-rate to the values of the horizontal intensity, H, and of the magnetic moment, m, as computed upon the basis of the approximate or zero rate originally assumed.

From the oscillation observations we have

$$mH = \frac{\pi^2 K}{T^2} \tag{3}$$

where K is the moment of inertia of the oscillating magnet and its suspension and T is the period in seconds of one oscillation with all corrections applied, including that arising from the chronometer rate. The relation between the observed period, T_o, corrected except for rate to the true period, T, is

$$T = T_o \frac{s'}{s} \tag{4}$$

where s is the length of a true second of time and s' the length of a second as given by the chronometer. If r is the daily rate of the chronometer in seconds, being positive for a losing and negative for a gaining rate, then

$$\frac{s'}{s} = \frac{86400}{86400 - r} \tag{5}$$

whence, from (4),

$$\Delta T = T - T_o = \frac{Tr}{86400} \tag{6}$$

From (3) we have, the subscript o indicating a value derived from oscillations only,

$$\Delta H_o = -\frac{2H}{T}\Delta T \tag{7}$$

$$\Delta m_o = -\frac{2m}{T}\Delta T \tag{8}$$

Substituting the value of ΔT from (6) in (7) and (8) and noting that the final computed value of H is the mean of H_o and of H_d (the value resulting from deflections only), we obtain

$$\Delta H = -Hr\,(1.1574 \times 10^{-5}) \tag{9}$$
$$\Delta m = -mr\,(1.1574 \times 10^{-5}) \tag{10}$$

These corrections apply when the original computations have been made with a zero rate; if any other rate has been used, r may be taken as the difference between the rate used and the adopted rate. Table 7 gives the values of the corrections from (9) and (10) for values of H from 0.02 to 0.40 C. G. S., for magnetic moment from 100 to 1000, and for daily rates of the chronometer from 1 second to 60 seconds.

A rapid approximation quite close enough for ordinary purposes, except when the rate is abnormally large, may be made without reference to the table from the formula

$$\Delta H = -\frac{7}{6}Hr \tag{11}$$

ΔH being in gammas, H in C. G. S. units, and r in seconds, with the usual convention as to sign.

TABLE 7.—*Corrections on Computed Values of Horizontal Intensity and of Magnetic Moment for Rate of Chronometer.*[1]

[Corrections are to be added for gaining rate and are to be subtracted for losing rate.]

Horizontal intensity, H	Rate of chronometer in seconds per day, r													
	1^s	2^s	3^s	4^s	5^s	6^s	7^s	8^s	9^s	10^s	15^s	30^s	45^s	60^s
	Horizontal-intensity correction, ΔH													
c. g. s.	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ
0.02	0.0	0.0	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.3	0.7	1.0	1.4
0.04	0.0	0.1	0.1	0.2	0.2	0.3	0.3	0.4	0.4	0.5	0.7	1.4	2.1	2.8
0.06	0.1	0.1	0.2	0.3	0.3	0.4	0.5	0.6	0.6	0.7	1.0	2.1	3.1	4.2
0.08	0.1	0.2	0.3	0.4	0.5	0.6	0.6	0.7	0.8	0.9	1.4	2.8	4.2	5.6
0.10	0.1	0.2	0.3	0.5	0.6	0.7	0.8	0.9	1.0	1.2	1.7	3.5	5.2	6.9
0.12	0.1	0.3	0.4	0.6	0.7	0.8	1.0	1.1	1.2	1.4	2.1	4.2	6.2	8.3
0.14	0.2	0.3	0.5	0.6	0.8	1.0	1.1	1.3	1.5	1.6	2.4	4.9	7.3	9.7
0.16	0.2	0.4	0.6	0.7	0.9	1.1	1.3	1.5	1.7	1.9	2.8	5.6	8.3	11.1
0.18	0.2	0.4	0.6	0.8	1.0	1.2	1.5	1.7	1.9	2.1	3.1	6.2	9.4	12.5
0.20	0.2	0.5	0.7	0.9	1.2	1.4	1.6	1.9	2.1	2.3	3.5	6.9	10.4	13.9
0.22	0.3	0.5	0.8	1.0	1.3	1.5	1.8	2.0	2.3	2.5	3.8	7.6	11.5	15.3
0.24	0.3	0.6	0.8	1.1	1.4	1.7	1.9	2.2	2.5	2.8	4.2	8.3	12.5	16.7
0.26	0.3	0.6	0.9	1.2	1.5	1.8	2.1	2.4	2.7	3.0	4.5	9.0	13.5	18.1
0.28	0.3	0.6	1.0	1.3	1.6	1.9	2.3	2.6	2.9	3.2	4.9	9.7	14.6	19.4
0.30	0.3	0.7	1.0	1.4	1.7	2.1	2.4	2.8	3.1	3.5	5.2	10.4	15.6	20.8
0.32	0.4	0.7	1.1	1.5	1.9	2.2	2.6	3.0	3.3	3.7	5.6	11.1	16.7	22.2
0.34	0.4	0.8	1.2	1.6	2.0	2.4	2.8	3.1	3.5	3.9	5.9	11.8	17.7	23.6
0.36	0.4	0.8	1.2	1.7	2.1	2.5	2.9	3.3	3.7	4.2	6.2	12.5	18.7	25.0
0.38	0.4	0.9	1.3	1.8	2.2	2.6	3.1	3.5	4.0	4.4	6.6	13.2	19.8	26.4
0.40	0.5	0.9	1.4	1.9	2.3	2.8	3.2	3.7	4.2	4.6	6.9	13.9	20.8	27.8
Magnetic moment, m	Magnetic-moment correction, Δm													
c. g. s.	*c. g. s.*	*c. g. s.*	*c. g. s.*	*c. g. s.*	*c. g. s.*	*c. g. s.*	*c. g. s.*	*c. g. s.*	*c. g. s.*	*c. g. s.*	*c. g. s.*	*c. g. s.*	*c. g. s.*	*c. g. s.*
100	.00	.00	.00	.00	.01	.01	.01	.01	.01	.01	.02	.03	.05	.07
200	.00	.00	.01	.01	.01	.01	.02	.02	.02	.02	.03	.07	.10	.14
300	.00	.01	.01	.01	.02	.02	.02	.03	.03	.03	.05	.10	.16	.21
400	.00	.01	.01	.02	.02	.03	.03	.04	.04	.05	.07	.14	.21	.28
500	.01	.01	.02	.02	.03	.03	.04	.05	.05	.06	.09	.17	.26	.35
600	.01	.01	.02	.03	.03	.04	.05	.06	.06	.07	.10	.21	.31	.42
700	.01	.02	.02	.03	.04	.05	.06	.06	.07	.08	.12	.24	.36	.49
800	.01	.02	.03	.04	.05	.06	.06	.07	.08	.09	.14	.28	.42	.56
900	.01	.02	.03	.04	.05	.06	.07	.08	.09	.10	.16	.31	.47	.62
1000	.01	.02	.03	.05	.06	.07	.08	.09	.10	.12	.17	.35	.52	.69

[1] The tabular corrections are on the basis that H and m are computed from oscillations and deflections without correcting the observed time of one oscillation for finally adopted rate of chronometer; for values of H and m based on oscillations only the tabular corrections must be doubled.

AFRICA.

Abyssinia.

Station	Latitude	Long. East of Gr.	Date	Declination Local Mean Time	Declination Value	Inclination L. M. T.	Inclination Value	Hor. Intensity L. M. T.	Hor. Intensity Value	Instruments Mag'r	Instruments Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Sedua	14 07.6 N	39 34	Sep 21, '14	9.2,11.1,16.8	1 28.9 W	14.9	9 32.3 N	9.7,10.6	.34985	10	202.1257	WFW
Makalle	13 30.3 N	39 28	Sep 15, 14	8.6 to 17.0(dv)	1 40.7 W	....	....	....	....	10	....	WFW
			Sep 16, 14	7.9,10.4	1 40.2 W	16.5	8 04.4 N	8.6, 9.7	.34962	10	202.1257	WFW
Adi Musseno	13 01.3 N	39 34	Sep 10, 14	8.9,10.8,17.3	1 38.4 W	15.1	6 52.7 N	9.4,10.3	.35500	10	202.1257	WFW
Balla	12 26.0 N	39 43	Sep 5, 14	8.2,10.3,17.1	1 57.9 W	16.0	7 16.2 N	8.8, 9.7	.35528	10	202.1257	WFW
Waldea	11 48.0 N	39 34	Aug 31, 14	9.4,11.3,17.1	1 47.4 W	15.8	4 08.6 N	10.0,10.8	.35089	10	202.1257	WFW
Dessié	11 06.5 N	39 33	Aug 20, 14	8.5,17.2	1 40.4 W	16.0	2 35.9 N	10.0,11.0	.35039	10	202.1257	WFW
			Aug 21, 14	9.7 to 17.6 (dv)	1 42.1 W	....	....	....	....	10	....	WFW
Aicha	10 44.6 N	42 37	Jun 10, 14	9.1,10.8	1 25.6 W	14.7	2 20.7 N	9.6,10.4	.34852	10	202.257	WFW
			Jun 11, 14	8.4,14.1,15.4	1 26.5 W	10.5	2 22.1 N	....	....	10	202.1257	WFW
Antorkia*	10 38.1 N	39 39	Aug 16, 14	9.0,15.8,16.7	1 05.3 E	14.7	0 53.7 N	10.4,11.2	.35711	10	202.1257	WFW
Angowa	10 11.2 N	39 41	Aug 11, 14	8.9	1 47.1 W	14.7	0 27.2 N	10.1,11.0	.35132	10	202.1257	WFW
Gimbaro-Mariam	9 43.8 N	39 33	Aug 5, 14	8.9,11.0	2 09.8 W	15.5	1 00.0 S	9.6,10.5	.34848	10	202.1257	WFW
Dire Daoua	9 34.9 N	41 54	Jun 16, 14	9.0,11.0,16.4	1 40.9 W	13.7	1 28.3 S	9.5,10.4	.34676	10	202.1257	WFW
Afdem	9 27.8 N	41 04	Jun 19, 14	8.9,10.7,16.4	1 38.2 W	14.4	1 50.8 S	9.4,10.2	.34874	10	202.1257	WFW
Goolaba	9 19.7 N	39 10	Jul 31, 14	10.1,11.3,17.6	2 13.7 W	14.7	3 10.4 S	16.3,17.1	.34884	10	202.1257	WFW
Addis Abeba, *Catholic Mission*	9 01.8 N	38 46	Oct 13, 18	8.1, 9.8	1 07.0 W	11.2	1 54.3 S	8.6, 9.5	.35198	17	223.1356	HES
Addis Abeba, *British Legation*	9 00.8 N	38 46	Jul 15, 14	11.3	2 14.1 W	....	....	15.6	.34505	10	....	WFW
			Jul 16, 14	11.4	2 15.6 W	15.8	2 17.3 S	10.8	.34576	10	202.1257	WFW
			Jul 17, 14	10.1 to 16.4 (dv)	2 15.1 W	....	....	....	....	10	....	WFW
Hawash	8 59.0 N	40 14	Jun 24, 14	9.4,11.3,16.2	2 21.7 W	14.4	2 29.6 S	10.0,10.8	.34660	10	202.1257	WFW
Ula Ula	8 53.2 N	39 41	Jun 30, 14	8.1 to 16.3 (4)	2 25.6 W	14.2	3 12.1 S	8.8, 9.7	.34839	10	202.1257	WFW
			Jul 1, 14	8.1 to 9.8 (dv)	2 23.9 W	....	....	....	....	10	....	WFW
			Jul 1, 14	13.5,15.5	2 25.6 W	....	....	....	....	10	....	WFW

Anglo-Egyptian Sudan.

Station	Latitude	Long. East of Gr.	Date	Declination Local Mean Time	Declination Value	Inclination L. M. T.	Inclination Value	Hor. Intensity L. M. T.	Hor. Intensity Value	Instruments Mag'r	Instruments Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Wadi Halfa	21 56 N	31 21	Jun 22, '18	7.5, 9.0	1 58.2 W	....	....	8.1, 8.7	.32906	17	....	HES
			Jun 23, 18	....	....	7.2	26 45.0 N	....	....	.....	223.1356	HES
Station No. 6	20 45.6 N	32 35	Jun 19, 18	7.5, 9.2	2 12.4 W	18.1	24 15.0 N	8.0, 8.8	.33374	17	223.1356	HES
Port Sudan	19 37.4 N	37 14	May 27, 14	11.1,14.6	1 51.3 W	16.9	21 35.3 N	13.2,14.0	.34042	10	202.1257	WFW
			May 28, 14	10.1,16.8	1 49.4 W	14.7	21 36.2 N	10.7,16.3	.34060	10	202.1257	WFW
			May 25, 18	6.4, 7.8	1 18.6 W	18.0	22 02.0 N	6.9, 7.5	.33986	17	223.1356	HES
Abu Hamed	19 32 N	33 20	Jun 16, 18	17.2,18.4	2 00.1 W	....	....	17.6,18.1	.33717	17	....	HES
			Jun 17, 18	....	....	8.9	21 47.3 N	....	....	.....	223.1356	HES
Shereik	18 47.0 N	33 38	Jun 15, 18	9.3,10.8	2 00.6 W	17.8	20 04.2 N	9.7,10.4	.34008	17	223.1356	HES
Sinkat	18 46 N	36 48	May 27, 18	15.9,17.9	1 23.1 W	....	....	16.3,17.6	.34220	17	....	HES
			May 28, 18	....	....	7.7	20 33.7 N	....	....	.....	223.1356	HES
Musmar	18 13.1 N	35 35	Jun 3, 18	7.9, 9.5	1 28.4 W	18.0	18 47.7 N	8.4, 9.2	.34326	17	223.1356	HES
Atbara	17 42 N	34 00	Jun 8, 18	6.8,17.1	2 00.0 W	....	....	7.3,16.8	.34228	17	....	HES
			Jun 9, 18	....	....	6.0	17 17.2 N	....	....	.....	223.1356	HES
Khartum	15 36 N	32 33	Dec 9, 17	10.4,12.3	2 44.6 W	....	....	10.9,12.0	.34303	17	....	HES
			Dec 10, 17	....	....	8.1	13 00.3 N	....	....	.....	223.1356	HES
Kassala	15 27 N	36 24	May 3, 18	7.4, 9.2	1 36.6 W	18.1	13 10.5 N	8.0, 8.9	.34529	17	223.1356	HES
El Getaineh	14 52 N	32 30	Jan 14, 18	9.6,11.4	2 39.5 W	14.5	11 20.1 N	10.1,11.1	.34526	17	223.1356	HES
Mogatta	14 42.5 N	35 52	Apr 29, 18	7.2, 8.6	1 48.7 W	10.2	10 56.8 N	7.6, 8.3	.34422	17	223.1356	HES
Gedaref	14 02 N	35 24	Apr 27, 18	10.1,11.7	2 17.4 W	6.5	9 43.0 N	10.5,11.4	.34751	17	223.1356	HES
El Dueim	13 59 N	32 19	Jan 16, 18	14.2,16.8	2 52.2 W	....	....	15.4,16.5	.34426	17	....	HES
			Jan 17, 18	....	....	11.5	9 10.5 N	....	....	.....	223.1356	HES
Abiat	13 45.3 N	26 30	Oct 8, 17	12.4,13.9	4 28.2 W	16.7	8 56.8 N	12.8,13.6	.34035	17	223.1356	HES
Om	13 39.1 N	24 31	Aug 31, 17	10.2,13.9	5 36.2 W	15.0	8 50.7 N	10.7,11.6	.33942	17	223.1356	HES
Kebkebia	13 38.5 N	24 01	Aug 28, 17	11.1,13.4	5 01.6 W	16.0	8 55.6 N	11.8,13.0	.33900	17	223.1356	HES
El-Fasher	13 37.6 N	25 21	Sep 15, 17	9.1,10.7	4 39.4 W	....	....	9.6,10.4	.33986	17	....	HES
			Sep 16, 17	6.4 to 17.3 (dv)	4 41.4 W	....	....	....	....	17	....	HES
			Sep 17, 17	....	....	8.1	8 34.7 N	....	....	.....	223.1356	HES
Rahad Sheraf	13 37.1 N	25 51	Oct 5, 17	9.0,10.6	4 31.1 W	13.6	8 40.7 N	9.5,10.4	.33830	17	223.1356	HES
Sennar	13 34.2 N	33 35	Nov 27, 17	8.8,10.9	2 44.8 W	....	....	9.4,10.4	.34620	17	....	HES
			Nov 28, 17	....	....	8.1	8 16.4 N	....	....	.....	223.1356	HES
Um Esheishat	13 33.7 N	26 51	Oct 11, 17	7.8, 9.8	4 23.4 W	13.8	8 37.4 N	8.3, 9.5	.34012	17	223.1356	HES
Camp August 22	13 32 N	23 06	Aug 22, 17	13.5,15.1	5 15.3 W	16.4	8 42.2 N	14.0,14.8	.33702	17	223.1356	HES
Asserni	13 30.8 N	22 38	Aug 19, 17	6.9 to 18.3 (dv)	5 22.0 W	....	....	....	....	17	....	HES
			Aug 20, 17	7.7, 9.4	5 20.0 W	10.9	8 48.1 N	8.3, 9.0	.33788	17	223.1356	HES
Shaba	13 30.7 N	24 50	Sep 3, 17	6.9 to 18.2 (dv)	4 48.4 W	....	....	....	....	17	....	HES
			Sep 4, 17	15.1,17.0	4 50.6 W	....	....	15.6,16.6	.34256	17	....	HES
			Sep 5, 17	....	....	9.1	7 48.8 N	....	....	.....	223.1356	HES

* Local disturbance.

AFRICA.

ANGLO-EGYPTIAN SUDAN—*Concluded.*

Station	Latitude	Long. East of Gr.	Date	Declination		Inclination		Hor. Intensity		Instruments		Obs'r
				Local Mean Time	Value	L. M. T.	Value	L. M. T.	Value	Mag'r	Dip Circle	
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Elga	13 29.7 N	23 33	Aug 24, '17	16.1,18.1	5 09.8 W	....	....	16.5,17.8	.33833	17	....	HES
			Aug 25, 17	....	....	8.6	8 21.3 N	....	....	....	223.1356	HES
Jebel Hella	13 27.1 N	27 08	Oct 13, 17	7.9, 9.8	4 18.6 W	15.9	8 13.8 N	8.4, 9.5	.34228	17	223.1356	HES
			Oct 14, 17	6.3 to 17.8 (dv)	4 20.8 W	....	....	....	....	17	....	HES
Djenené	13 25.4 N	22 24	Aug 14, 17	13.8	5 36.5 W	....	....	....	....	17	....	HES
			Aug 15, 17	7.0, 9.0	5 27.6 W	14.4	8 35.5 N	7.3, 8.6	.33742	17	223.1356	HES
Dam Gamad	13 16.6 N	27 31	Oct 16, 17	9.2,10.6	4 14.8 W	15.6	7 44.5 N	9.6,10.3	.34133	17	223.1356	HES
El Obeid	13 10.7 N	30 14	Nov 13, 17	8.8,10.8	3 36.8 W	....	....	9.3,10.4	.34338	17	....	HES
			Nov 15, 17	....	....	8.6	7 22.9 N	....	....	....	223.1356	HES
			Nov 16, 17	6.8 to 10.9 (dv)	3 38.6 W	....	....	....	....	17	....	HES
Kosti	13 10.3 N	32 40	Nov 23, 17	9.7,11.6	2 57.6 W	....	....	10.3,11.2	.34480	17	....	HES
			Nov 24, 17	....	....	9.5	7 04.9 N	....	....	....	223.1356	HES
Nyemeir	13 08.8 N	29 50	Nov 4, 17	7.9, 9.3	3 45.6 W	10.3	7 21.4 N	8.3, 9.0	.34358	17	223.1356	HES
Dudieh	13 06.2 N	29 25	Nov 2, 17	10.7,12.6	3 44.2 W	14.4	7 11.3 N	11.1,12.3	.34326	17	223.1356	HES
Wad Banda	13 05.5 N	28 01	Oct 18, 17	12.9,14.3	4 09.4 W	17.6	7 27.3 N	13.3,14.0	.34115	17	223.1356	HES
Markib	12 55.3 N	28 54	Oct 31, 17	13.8,15.7	3 54.4 W	17.3	6 50.6 N	14.3,15.3	.34186	17	223.1356	HES
Um Ruaba	12 54.4 N	31 13	Nov 18, 17	....	....	....	....	17.0	.34388	17	....	HES
			Nov 19, 17	6.3 to 17.4 (dv)	3 21.2 W	....	....	....	....	17	....	HES
			Nov 20, 17	11.3,13.6	3 22.0 W	....	....	12.6,13.2	.34426	17	....	HES
			Nov 21, 17	....	....	7.3	6 32.2 N	....	....	....	223.1356	HES
El Nahud	12 40.3 N	28 28	Oct 25, 17	7.7, 9.3	4 11.4 W	10.6	6 24.0 N	8.2, 9.0	.34136	17	223.1356	HES
			Oct 29, 17	6.7 to 17.7 (dv)	4 07.7 W	....	....	....	....	17	....	HES
Golietta	12 17.7 N	32 41	Apr 13, 18	10.8,15.3	2 53.0 W	17.2	5 18.6 N	14.0,14.9	.34409	17	223.1356	HES
Renk	11 45.0 N	32 47	Jan 23, 18	13.9,15.4	3 05.2 W	....	....	14.3,15.0	.34424	17	....	HES
			Jan 24, 18	....	....	9.8	3 53.8 N	....	....	....	223.1356	HES
El Galhak	11 03.3 N	32 32	Jan 26, 18	8.9,10.6	3 10.8 W	13.8	2 17.6 N	9.4,10.1	.34454	17	223.1356	HES
Melut	10 26.6 N	32 09	Jan 30, 18	10.0,11.9	3 23.4 W	....	....	10.5,11.5	.34308	17	....	HES
			Jan 31, 18	6.7 to 17.9 (dv)	3 23.7 W	....	....	....	....	17	....	HES
			Feb 1, 18	....	....	8.9	0 46.9 N	....	....	....	223.1356	HES
Kodok	9 53.0 N	32 07	Feb 3, 18	14.4,16.0	2 58.2 W	....	....	14.8,15.7	.33177	17	....	HES
			Feb 4, 18	....	....	11.0	1 46.1 S	....	....	....	223.1356	HES
Malakal	9 32.1 N	31 38	Feb 6, 18	16.6,17.9	3 44.1 W	11.5	1 15.1 S	16.9,17.6	.34044	17	223.1356	HES
Tongo	9 28.1 N	31 04	Feb 11, 18	17.0	3 49 W	11.0	1 11.9 S	16.7,17.4	.33979	17	223.1356	HES
Taufikia	9 25 N	31 37	Feb 8, 18	10.5,12.1	3 39.0 W	17.5	1 31.0 S	11.1,11.8	.34171	17	223.1356	HES
Kilometer 285, Bahr el Zeraf	7 48 N	30 37	Mar 27, 18	11.7,13.3	4 09.2 W	15.2	5 38.3 S	12.2,13.0	.33821	17	223.1356	HES
Shambe	7 07 N	30 50	Mar 21, 18	6.9, 8.4	4 35.6 W	12.2	7 25.8 S	7.4, 8.1	.33310	17	223.1356	HES
Bor	6 12.4 N	31 36	Mar 13, 18	8.8,10.3	4 25.0 W	16.9	9 20.1 S	9.3,10.0	.33407	17	223.1356	HES
			Mar 14, 18	6.6 to 17.9 (dv)	2 24.1 W	....	....	....	....	17	....	HES
Mongalla	5 11.8 N	31 48	Mar 8, 18	8.4,11.1	4 07.6 W	17.7	11 50.0 S	8.9, 9.7	.33060	17	223.1356	HES

ANGOLA.

Station	Latitude	Long. East of Gr.	Date	Decl. Local Mean Time	Decl. Value	Incl. L. M. T.	Incl. Value	Hor. Int. L. M. T.	Hor. Int. Value	Mag'r	Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Chiloango	5 12.1 S	12 08	Apr 6, '15	10.1,11.2	13 44.4 W	14.8	30 57.9 S	10.4,11.0	.27318	16	222.1256	DMW
Cabinda	5 32.3 S	12 12	Apr 1, 15	10.0,11.2	14 06.0 W	17.0	31 39.4 S	10.3,10.9	.27102	16	222.1256	DMW
			May 31, 16	12.3,14.3	13 57.4 W	16.2	31 50.4 S	12.8,13.9	.27058	17	223.1356	HES
Ambriz	7 49.7 S	13 02	Mar 29, 15	10.4,11.4	14 59.2 W	13.4	35 43.8 S	10.6,11.2	.25974	16	222.1256	DMW
Loanda Island	8 46.8 S	13 14	Feb 24, 15	12.7,14.0	15 13.8 W	16.4	36 43.0 S	13.0,13.7	.25692	16	222.1256	DMW
Loanda	8 48.8 S	13 14	Dec 31, 14	9.2,11.4	15 18.5 W	15.0	36 37.8 S	9.6,11.1	.25771	16	222.1256	DMW
			Mar 19, 15	13.2,14.5	15 15.2 W	16.2	36 42.7 S	13.5,14.2	.25720	16	222.1256	DMW
			Mar 20, 15	7.3 to 18.0 (dv)	15 15.6 W	....	....	....	....	16	....	DMW
			May 29, 16	8.1,10.0	15 04.6 W	13.2	36 45.4 S	8.7, 9.7	.25704	17	223.1356	HES
			Feb 16, 20	6.9, 8.3	14 36.5 W	....	....	7.3, 8.0	.25606	13	....	FB
			Feb 17, 20	....	....	10.2	37 16.2 S	....	....	....	177.4X	FB
			Feb 18, 20	6.3 to 18.1 (dv)	14 32.5 W	....	....	....	....	13	....	FB
			Mar 1, 20	5.9 to 18.1 (dv)	14 32.7 W	....	....	....	....	13	....	FB
			Mar 3, 20	9.7,11.1	14 31.6 W	16.5	37 17.0 S	10.0,10.8	.25622	13	177.4X	FB
Loanda, *João Capello Observatory, A*	8 48.8 S	13 13	Mar 10, 20	....	....	13.9,15.6	37 20.6 S	....	....	....	177.2X[1]	FB
			Mar 11, 20	....	....	14.2,17.0	37 22.7 S	....	....	....	177.2X[1]	FB
			Mar 12, 20	....	....	7.5, 9.3	37 22.1 S	....	....	....	177.2X[1]	FB
Loanda, *João Capello Observatory, B*	8 48.8 S	13 13	Mar 11, 20	7.2 to 11.1 (7)	14 41.0 W	....	....	....	....	13	....	FB
Cabiri	8 53 S	13 38	Jan 15, 15	8.4,10.5	15 36.6 W	15.2	37 10.4 S	8.8, 9.4	.25711	16	222.1256	DMW
Lucala	9 16.7 S	15 15	Jan 8, 15	13.4,14.7	14 42.6 W	16.7	40 32.7 S	13.7,14.4	.24646	16	222.1256	DMW
			Jan 9, 15	6.1 to 18.1 (dv)	14 43.7 W	....	....	....	....	16	....	DMW
Cassoalala	9 29.6 S	14 22	Jan 6, 15	8.7,10.0	15 49.1 W	13.6	39 15.2 S	9.0, 9.6	.25161	16	222.1256	DMW
Cassoalala, *1920*	9 29.6 S	14 22	Feb 26, 20	7.3, 8.8	15 06.8 W	10.7	39 57.4 S	7.7, 8.5	.24946	13	177.4X[2]	FB

[1] 13X and 14X only. [2] 13X rejected.

AFRICA.

ANGOLA—*Concluded.*

Station	Latitude	Long. East of Gr.	Date	Declination: Local Mean Time	Declination: Value	Inclination: L. M. T.	Inclination: Value	Hor. Intensity: L. M. T.	Hor. Intensity: Value	Instruments: Mag'r	Instruments: Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Malange	9 33.0 S	16 21	Jan 12, '15	10.3,11.4	14 46.8 W	13.5	39 15.7 S	10.6,11.1	.25232	16	222.15	DMW
			Feb 24, 20	10.6,12.0	13 54.3 W	16.4	39 53.2 S	10.9,11.7	.25054	13	177.4X[1]	FB
Bumba	11 06.1 S	23 50	Jun 6, 20	16.2,17.5	12 07.7 W	14.8	43 32.2 S	16.6,17.2	.24672	13	177.4X	FB
Novo Redondo	11 11 S	13 48	Feb 21, 15	13.0,13.2	16 43.0 W	13.7	40 50.4 S	12.5	.24595	16	222.15	DMW
Calengo	11 16.6 S	21 32	May 17, 20			17.3	43 18.2 S				177.4X	FB
			May 18, 20	5.7 to 16.1 (dv)	12 49.7 W					13		FB
			May 18, 20	16.4,17.7	12 49.9 W			16.8,17.4	.24518	13		FB
Mwandeje	11 18.0 S	23 28	Jun 4, 20	9.5,10.9	12 25.0 W	15.1	43 12.6 S	9.9,10.6	.24509	13	177.4X	FB
Chabaia	11 26.5 S	21 04	May 15, 20	10.2,11.6	13 18.6 W	15.4	43 23.4 S	10.6,11.3	.24354	13	177.4X	FB
Dilolo	11 30.0 S	22 02	May 21, 20	9.9,11.4	12 56.2 W	15.1	43 40.5 S	10.3,11.1	.24338	13	177.4X	FB
Kavungo, *B*	11 31.2 S	23 02	May 29, 20	16.3,17.7	12 32.6 W			16.7,17.4	.24750	13		FB
			May 30, 20	6.1 to 18.1 (dv)	12 34.0 W					13		FB
			Jun 1, 20			11.0	43 51.5 S				177.4X	FB
Kavungo, *A*	11 31.5 S	23 03	May 27, 20	16.3,17.7	12 26.2 W	10.5	43 37.3 S	16.7,17.4	.24770	13	177.4X[2]	FB
Cazeze	11 32.4 S	20 45	May 13, 20	9.0,10.4	13 22.9 W	13.6	43 20.9 S	9.3,10.1	.24372	13	177.4X[1]	FB
Rio Luambo	11 40.5 S	22 34	May 24, 20	7.6, 9.0	12 40.8 W	13.6	43 32.1 S	8.0, 8.7	.24852	13	177.4X[2]	FB
Boma	11 48.8 S	20 09	May 4, 20	14.4,15.7	13 30.3 W			14.7,15.4	.24138	13		FB
			May 5, 20	5.7 to 18.1 (dv)	13 32.2 W					13		FB
			May 6, 20			10.4	43 44.4 S				177.4X[1]	FB
Moxico	11 51.0 S	20 03	May 3, 20	11.0,15.7	13 37.7 W	17.0	43 51.4 S	11.4,15.3	.24113	13	177.4X	FB
Cuanza	11 55.0 S	17 46	Apr 20, 20	17.1,17.9	14 50.8 W	16.1	43 27.0 S	17.4	.23935	13	177.4X	FB
Lumeje	11 56.0 S	19 32	Apr 30, 20	9.2,10.7	13 57.7 W	14.8	43 49.4 S	9.6,10.4	.24038	13	177.4X[3]	FB
Rio Chiemba	12 02.8 S	18 21	Apr 23, 20			17.2	44 03.9 S				177.4X[3]	FB
			Apr 24, 20	7.5, 7.8	14 16.0 W			6.9	.23767	13		FB
Chissamba	12 10.2 S	17 25	Apr 17, 20	10.5,14.1	14 58.0 W	15.3	43 33.1 S	10.9,11.6	.23770	13	177.4X	FB
Muhango	12 11.5 S	18 44	Apr 26, 20	12.8,15.4	14 11.4 W	16.3	44 27.2 S	13.1,13.9	.23675	13	177.4X[2]	FB
Lobito, *B*	12 20.5 S	13 34	Mar 19, 20	9.4,10.8,11.1	16 04.1 W	16.2	43 33.9 S	9.8,10.5	.23445	13	177.4X	FB
Lobito, *A*	12 20.9 S	13 34	Feb 14, 15	10.5,12.1	16 56.2 W	8.4	42 46.7 S	10.8,11.7	.23650	16	222.1256	DMW
			Feb 15, 15	6.9 to 18.3 (dv)	16 55.0 W					16		DMW
			Mar 22, 20	10.6,15.6	16 11.8 W	9.8	43 27.4 S	11.0,11.7	.23480	13	177.4X[2]	FB
Belmonte	12 21.8 S	17 03	Apr 15, 20	15.4,16.2	15 26.0 W	13.9	44 16.6 S	15.8	.23430	13	177.4X[2]	FB
Camundongo	12 31.1 S	17 08	Apr 12, 20	9.5,11.0	15 22.6 W	15.2	43 53.0 S	9.9,10.7	.23821	13	177.4X	FB
Bela Vista	12 32.2 S	16 17	Apr 5, 20	10.1,11.8	17 47.2 W	14.9	44 39.6 S	10.5,11.4	.22872	13	177.4X[3]	FB
Xinguari	12 33.1 S	16 24	Apr 7, 20	16.9,17.8	15 27.2 W	16.1	43 42.4 S	17.3	.23744	13	177.4X	FB
Chinguar	12 33.7 S	16 23	Feb 1, 15	13.2,15.0	16 24.4 W			13.6,14.6	.24082	16		DMW
			Feb 2, 15			14.0	43 02.0 S				222.1256	DMW
Benguela	12 34.6 S	13 24	Jan 22, 15	13.2,14.8	17 15.8 W	17.2	43 36.1 S	13.6,14.4	.23548	16	222.1256	DMW
			Mar 16, 20	10.5,12.0	16 29.8 W	15.0	44 18.8 S	10.9,11.7	.23312	13	177.4X	FB
			Mar 17, 20			16.7	44 21.6 S				177.4X	FB
Huambo, *B*	12 45.3 S	15 47	Apr 1, 20	13.8,15.2	16 22.2 W	17.2	44 24.6 S	14.2,14.9	.23600	13	177.4X	FB
			Apr 2, 20	5.8 to 18.1 (dv)	16 22.2 W					13		FB
Huambo, *A*	12 46.3 S	15 46	Jan 29, 15	13.3,14.5	16 50.6 W	15.6	43 34.6 S	13.6,14.2	.23812	16	222.1256	DMW
			Apr 3, 20	10.4,11.8	16 01.2 W	14.8	44 23.8 S	10.8,11.5	.23521	13	177.4X	FB
Cuma	12 52.2 S	15 02	Jan 24, 15	16.8,18.0	17 08.0 W			17.1,17.7	.23566	16		DMW
			Jan 25, 15			10.4	43 23.4 S				222.1256	DMW
Catengue	13 01.5 S	13 44	Feb 8, 15	8.7,11.2	17 46.6 W	15.9	43 12.5 S	9.0,10.3	.23566	16	222.1256	DMW
Cubal	13 02.9 S	14 16	Jan 26, 15	9.8,11.4	17 13.2 W	14.8	43 42.0 S	10.2,11.0	.23492	16	222.1256	DMW
Mossamedes	15 10.9 S	12 09	Mar 7, 15	10.2,11.4	19 02.4 W	16.7	45 10.0 S	10.5,11.1	.22455	16	222.1256	DMW
			May 24, 16	9.2,13.0	18 50.0 W	16.0	45 24.8 S	10.3,11.4	.22376	17	223.1356	HES
Port Alexandre	15 47.6 S	11 49	Mar 12, 15	10.4,11.8	19 57.4 W	8.6	46 15.8 S	10.8,11.5	.22230	16	222.1256	DMW
Tiger Bay	16 35 S	11 44	Mar 10, 15	15.4,16.2	20 07.6 W	17.0	46 38.8 S	15.7	.22062	16	222.56	DMW

BELGIAN CONGO.

Station	Latitude	Long. East of Gr.	Date	Declination: Local Mean Time	Declination: Value	Inclination: L. M. T.	Inclination: Value	Hor. Intensity: L. M. T.	Hor. Intensity: Value	Instruments: Mag'r	Instruments: Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Lisala	2 08.4 N	21 32	Apr 29, '14	10.3,12.6	8 25.2 W	14.6	17 45.5 S	10.9,12.1	.31382	16	222.1256	DMW
Bosoko	1 13.5 N	23 38	May 4, 14	15.4,17.8	7 56.5 W	11.2	20 22.4 S	15.8,17.4	.31183	16	222.1256	DMW
Stanleyville	0 31.0 N	25 11	May 13, 14	9.5,11.4	7 48.4 W	7.2	21 52.1 S	10.0,11.0	.31024	16	222.1256	DMW
			May 16, 14	6.1 to 8.2 (dv)	7 45.4 W					16		DMW
			May 16, 14	8.5 to 17.3 (dv)	7 47.6 W					16		DMW
			May 16, 14	17.5	7 47.1 W					16		DMW
Coquilhatville	0 03.9 N	18 18	Apr 23, 14	10.5,12.4	9 56.4 W	14.0	21 49.6 S	10.9,12.0	.30310	16	222.56	DMW
Ponthierville	0 22.1 S	25 24	May 20, 14			17.0	23 51.3 S				222.1256	DMW
			May 21, 14	10.1,10.7	8 04.8 W			6.9, 8.3	.30504	16		DMW
			May 21, 14	11.5,11.7	8 06.0 W					16		DMW
Lukolela	1 02.8 S	17 14	Apr 14, 14	15.4,18.2	10 40.4 W			15.8,17.7	.29660	16		DMW
			Apr 15, 14			8.2	24 01.6 S				222.1256	DMW
			Apr 17, 14	6.4 to 17.9 (dv)	10 41.2 W					16		DMW
Lowa	1 23.8 S	25 47	May 26, 14	14.3,16.6	8 17.8 W			15.3,16.2	.30072	16		DMW
			May 27, 14			10.5	25 58.4 S				222.1256	DMW

[1] 13X rejected. [2] 15X rejected. [3] 14X rejected.

AFRICA.

BELGIAN CONGO—*Continued.*

Station	Latitude	Long East of Gr.	Date	Declination: Local Mean Time	Declination: Value	Inclination: L. M. T.	Inclination: Value	Hor. Intensity: L. M. T.	Hor. Intensity: Value	Instruments: Mag'r	Instruments: Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Bolobo	2 00.6 S	16 17	Apr 8, '14	6.7, 9.1	11 27.0 W	11.1	26 03.2 S	7.2, 8.5	.29113	16	222.1256	DMW
Bolobo, *B*	2 00.6 S	16 17	Nov 27, 16	15.4,17.2	11 03.0 W	....	....	16.2,16.9	.29114	17	....	HES
			Nov 28, 16	6.0 to 17.6 (dv)	11 02.4 W	....	....	....	....	17	....	HES
			Nov 29, 16	....	....	16.0	26 12.8 S	....	....	....	223.1356	HES
Bolobo, *C*	2 00.6 S	16 17	Dec 4, 16	9.8,11.8	11 02.0 W	15.7	26 23.0 S	10.4,11.5	.29002	17	223.1356	HES
Waika	2 23.3 S	25 41	May 30, 14	14.7	8 39.4 W	11.4	27 52.8 S	16.4	.29588	16	222.1256	DMW
			Jun 1, 14	8.9,10.1	8 38.6 W	....	....	9.4	.29567	16	....	DMW
Kindu	2 56.8 S	25 55	Jun 2, 14	13.8,15.4	8 50.9 W	....	....	14.2,15.0	.20364	16	....	DMW
			Jun 3, 14	....	....	10.1	20 11.3 S	....	....	....	222.1256	DMW
Kwamouth	3 10.7 S	16 16	Apr 3, 14	7.6,10.5	11 56.4 W	16.2	28 09.3 S	8.0,10.0	.28470	16	222.1256	DMW
			Apr 4, 14	8.1,10.4	11 56.6 W	....	....	8.6,10.0	.28454	16	....	DMW
Dima	3 16.3 S	17 31	Nov 18, 14	8.2, 9.7	11 24.4 W	10.7	28 39.4 S	8.5, 9.3	.28630	16	222.56	DMW
Eolo	3 42.9 S	18 56	Nov 14, 14	9.4,10.9	11 14.4 W	15.7	29 50.6 S	9.8,10.6	.28384	16	222.1256	DMW
Bolombo	4 01.2 S	21 22	Nov 2, 14	12.4,13.4	10 30.8 W	14.1	30 48.4 S	12.8	.28460	16	222.56	DMW
Bena Dibele	4 06.9 S	22 51	Nov 9, 14	9.4,10.9	9 56.8 W	7.6	30 54.4 S	9.8,10.5	.28580	16	222.56	DMW
Basongo	4 19.2 S	20 22	Oct 27, 14	....	....	17.2	31 29.2 S	....	....	....	222.1256	DMW
			Oct 28, 14	15.4,17.2	10 28.7 W	....	....	15.8,16.8	.27969	16	....	DMW
Leopoldville, *A*	4 19.7 S	15 14	Mar 23, 14	13.4,16.0	12 53.2 W	....	....	14.0,15.5	.27880	16	....	DMW
			Mar 24, 14	11.8	12 52.2 W	16.2	30 01.6 S	12.3,12.8	.27962	16	222.1256	DMW
			Jun 24, 16	10.9,12.0	12 31.4 W	14.0	30 14.3 S	9.6,10.5	.27870	17	223.1356	HES
Leopoldville, *B*	4 19.7 S	15 14	Nov 24, 14	8.0 to 17.7 (dv)	12 47.4 W	....	....	....	....	16	....	DMW
			Nov 25, 14	11.6,13.2	12 45.4 W	14.9	30 05.8 S	12.0,12.8	.27920	16	222.1256	DMW
Malela	4 24.0 S	26 08	Jun 5, 14	17.9,18.3	9 12.8 W	....	....	21.6,22.8	.28656	16	....	DMW
			Jun 6, 14	....	....	6.3	32 00.6 S	....	....	....	222.156	DMW
Bashishombe	4 39.1 S	21 00	Oct 25, 14	17.0,17.2	10 26.8 W	....	....	....	....	16	....	DMW
			Oct 26, 14	....	....	7.1	31 36.6 S	9.7,10.3	.28170	16	222.1256	DMW
			Oct 26, 14	....	....	8.4	31 35.6 S	....	....	....	222.15	DMW
Lusambo	4 58.3 S	23 26	Nov 7, 14	11.4,12.0	10 08.0 W	14.3	32 33.5 S	11.8,12.6	.28099	16	222.1256	DMW
Tshela	5 00.2 S	12 58	Dec 16, 14	16.5,17.8	13 45.6 W	....	....	16.9,17.6	.27382	16	....	DMW
			Dec 17, 14	....	....	10.7	30 48.7 S	....	....	....	222.1256	DMW
Thysville	5 15.1 S	14 54	Mar 17, 14	8.7,11.0	13 26.7 W	15.8	31 46.6 S	9.2,10.3	.27378	16	222.1256	DMW
			Mar 18, 14	6.4 to 15.4 (dv)	13 24.2 W	....	....	....	....	16	....	DMW
			Mar 18, 14	16.6	13 24.0 W	....	....	....	....	16	....	DMW
Luebo	5 20.0 S	21 24	Oct 20, 14	6.1	11 18.1 W	....	....	....	....	16	....	DMW
			Oct 20, 14	6.4 to 17.6 (dv)	11 18.8 W	....	....	....	....	16	....	DMW
			Oct 21, 14	10.0,11.6	11 17.8 W	14.2	33 05.2 S	10.4,11.3	.27678	16	222.1256	DMW
Kongolo	5 23.0 S	27 02	Jun 7, 14	10.1,11.8	9 28.4 W	15.4	34 01.7 S	10.5,11.4	.28214	16	222.1256	DMW
Djoka Punda*	5 27 S	20 59	Oct 24, 14	13.7,15.3	10 35.2 W	11.0	33 23.4 S	14.1,15.0	.27655	16	222.156	DMW
Fardiala	5 34.4 S	21 48	Oct 16, 14	13.7,15.0	11 16.2 W	....	....	14.0,14.7	.27554	16	....	DMW
			Oct 17, 14	....	....	6.9	33 37.2 S	....	....	....	222.156	DMW
Matadi	5 49.4 S	13 28	Dec 11, 14	10.8,12.2	13 47.6 W	15.3	32 07.8 S	11.2,11.9	.27117	16	222.1256	DMW
Matadi, *1920*	5 49.4 S	13 28	Feb 7, 20	....	....	17.6	33 08.8 S	....	....	....	177.4X	FB
			Feb 8, 20	6.8, 8.1	12 51.4 W	....	....	7.2, 7.8	.26880	13	....	FB
Boma	5 51.5 S	13 04	Mar 11, 14	10.2,12.8	14 08.4 W	....	....	10.7,12.2	.27188	16	....	DMW
			Mar 12, 14	....	....	7.4	31 59.5 S	....	....	....	222.1256	DMW
			Dec 20, 14	6.5, 7.9	14 03.2 W	10.6	32 00.8 S	6.8, 7.6	.27155	16	222.1256	DMW
			Jun 3, 16	8.8,10.9	13 46.8 W	16.1	32 16.2 S	9.4,10.5	.27114	17	223.1356	HES
			Jun 4, 16	7.1 to 17.3 (dv)	13 47.4 W	....	....	....	....	17	....	HES
			Oct 20, 16	6.3 to 17.8 (dv)	13 41.9 W	....	....	....	....	17	....	HES
			Oct 21, 16	14.4,16.2	13 43.0 W	....	....	14.8,15.9	.27068	17	....	HES
			Oct 22, 16	....	....	9.7	32 16.5 S	....	....	....	223.1356	HES
			Feb 5, 20	17.0,18.3	13 18.0 W	16.0	32 41.1 S	17.4,18.0	.27036	13	177.4X	FB
Chinquengue	5 52 S	13 08	Nov 7, 16	8.8,10.5	13 42.4 W	15.2	32 23.4 S	9.3,10.2	.27060	17	223.1356	HES
Kilometer 225	5 53.3 S	28 53	Jun 18, 14	....	....	17.5	35 07.2 S	....	....	....	222.1256	DMW
			Jun 19, 14	7.2, 9.8	8 52.3 W	....	....	8.1, 9.3	.28192	16	....	DMW
Kilometer 123	5 57.4 S	28 02	Jun 20, 14	14.1,15.6	9 19.4 W	11.2	35 14.4 S	14.5,15.2	.27886	16	222.125	DMW
Banana	6 00.4 S	12 26	Dec 22, 14	10.0,11.2	14 24.9 W	17.2	32 21.4 S	10.3,10.9	.26922	16	222.1256	DMW
Banana, *1920*	6 00.4 S	12 26	Feb 10, 20	7.9, 9.3	13 42.1 W	....	....	8.2, 9.0	.26757	13	....	FB
			Feb 11, 20	....	....	8.9	32 59.6 S	....	....	....	177.4X	FB
Luluabourg	6 01.9 S	22 10	Oct 13, 14	14.0,15.4	10 51.8 W	17.4	34 57.5 S	14.4,15.1	.27315	16	222.15	DMW
Kabalo	6 03.1 S	26 56	Jun 10, 14	13.3,15.0	9 42.0 W	10.6	35 07.7 S	13.7,14.6	.27843	16	222.1256	DMW
Kyembi	6 41 S	22 49	Oct 7, 14	13.8,15.1	12 00.4 W	16.9	35 46.4 S	14.2,14.8	.27097	16	222.1256	DMW
Ankoro	6 44.4 S	26 59	Jun 12, 14	9.3,11.2	9 56.4 W	15.3	36 30.8 S	9.8,10.7	.27463	16	222.1256	DMW
			Jun 13, 14	7.3 to 16.7 (dv)	9 53.5 W	....	....	....	....	16	....	DMW
Tshibangu	7 12.1 S	23 03	Oct 4, 14	14.3,15.6	11 23.8 W	17.6	36 25.2 S	14.6,15.2	.27112	16	222.156	DMW
Mukomwela	7 43.8 S	22 58	Sep 30, 14	13.2,14.7	11 41.6 W	15.8	37 40.1 S	13.6,14.3	.26974	16	222.1256	DMW
Tshiwana	7 56.2 S	22 47	Sep 27, 14	14.1,15.6	11 49.4 W	17.3	37 53.6 S	14.5,15.2	.26504	16	222.15	DMW
Kadia	8 16.0 S	26 38	Jul 1, 14	14.5,16.3	10 43.4 W	....	....	15.0,16.0	.26550	16	....	DMW
			Jul 2, 14	....	....	8.6	38 59.7 S	....	....	....	222.1256	DMW
Kapanga	8 25.6 S	22 31	Sep 22, 14	16.6	11 59.1 W	....	....	16.9,17.6	.20302	16	....	DMW
			Sep 23, 14	7.1 to 17.0 (dv)	12 00.7 W	....	....	....	....	16	....	DMW
			Sep 24, 14	....	....	10.7	38 29.2 S	....	....	....	222.1256	DMW
Tshitala	8 59.6 S	23 10	Sep 16, 14	13.2,14.7	12 07.2 W	16.6	39 38.7 S	13.6,14.4	.26079	16	222.1256	DMW

* Local disturbance.

AFRICA.

BELGIAN CONGO—*Concluded.*

Station	Latitude	Long. East of Gr.	Date	Declination		Inclination		Hor. Intensity		Instruments		Obs'r
				Local Mean Time	Value	L. M. T.	Value	L. M. T.	Value	Mag'r	Dip Circle	
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Bukama	9 11.6 S	25 52	Jul 8, '14	10.7,13.4	11 32.7 W	17.2	40 19.4 S	11.1,13.0	.26104	16	222.12	DMW
Ulamba	9 16.8 S	23 25	Sep 13, 14	13.4,15.1	12 16.9 W	16.9	40 14.8 S	13.9,14.7	.25838	16	222.1256	DMW
Kafakumba	9 40.7 S	23 41	Sep 6, 14	10.2,11.6	12 13.2 W	....	....	10.5,11.3	.25669	16	....	DMW
			Sep 7, 14	....	....	9.6	40 42.8 S	....	....	.....	222.1256	DMW
Mazanguli	9 43.9 S	25 44	Jul 13, 14	13.5,15.2	11 47.3 W	17.4	41 09.5 S	14.1,14.9	.25769	16	222.125	DMW
Sakepalo	9 50.7 S	23 52	Sep 3, 14	8.8,10.7	11 55.8 W	14.0	41 22.4 S	9.2,10.3	.25578	16	222.1256	DMW
Kapiri	10 19.0 S	26 14	Jul 19, 14	15.0,16.7	11 40.8 W	....	....	15.4,16.3	.25318	16	....	DMW
			Jul 20, 14	....	....	7.0	42 32.6 S	....	....	.....	222.125	DMW
Kayoyo	10 34.9 S	24 16	Aug 29, 14	13.5,15.2	12 33.6 W	17.4	42 21.8 S	13.9,14.8	.25084	16	222.1256	DMW
Ruwe	10 40.7 S	25 32	Aug 21, 14	11.3 to 16.9 (dv)	12 20.0 W	....	....	9.0, 9.9	.25189	16	....	DMW
			Aug 22, 14	....	....	7.3	42 41.7 S	....	....	.....	222.1256	DMW
			Jun 17, 20	14.6,16.0	11 10.4 W	11.1	43 04.2 S	15.0,15.7	.24972	13	177.4X	FB
Kambove	10 52.8 S	26 37	Jul 25, 14	14.4,16.1	11 56.7 W	17.4	43 17.1 S	14.8,15.7	.25030	16	222.1256	DMW
			Jul 27, 14	7.0 to 17.6 (dv)	11 58.6 W	....	....	....	....	16	....	DMW
			Jun 22, 20	11.0,15.7	10 50.6 W	17.0	43 48.5 S	11.4,15.4	.24774	13	177.4X	FB
Kimbundji	10 53.1 S	25 02	Aug 24, 14	13.4,15.0	12 39.6 W	17.0	42 36.7 S	13.8,14.7	.25138	16	222.125	DMW
Lufupa River	10 56.5 S	25 02	Jun 14, 20	....	....	17.5	43 20.2 S	....	....	.....	177.2X[1]	FB
			Jun 15, 20	6.7	11 36.2 W	....	....	7.3	.24896	15	....	FB
Musokantanda Plain	11 02.8 S	24 40	Jun 11, 20	16.4,17.6	11 41.4 W	....	....	16.7,17.4	.24648	13	....	FB
			Jun 12, 20	....	....	13.5	43 21.9 S	....	....	.....	177.4X	FB
Elisabethville	11 40.0 S	27 29	Jul 31, 14	9.6,11.3	12 16.0 W	15.8	44 20.0 S	10.0,10.9	.24791	16	222.1256	DMW
			Jun 30, 20	14.1,15.5	11 02.5 W	11.1	44 39.4 S	14.5,15.2	.24530	13	177.4X[3]	FB
			Jul 1, 20	6.0 to 18.1 (dv)	11 02.2 W	....	....	....	....	13	....	FB
Tshinsenda	12 18.2 S	27 58	Aug 6, 14	....	....	16.1	45 26.4 S	....	....	.....	222.1256	DMW
			Aug 7, 14	9.8,11.5	12 07.8 W	....	....	10.3,11.1	.24412	16	....	DMW
Sakania	12 45.0 S	28 33	Aug 3, 14	14.7,16.3	11 56.2 W	....	....	15.1,16.0	.24269	16	....	DMW
			Aug 4, 14	....	....	11.0	46 12.2 S	....	....	.....	222.1256	DMW

BRITISH SOUTH AND CENTRAL AFRICA.

Station	Latitude	Long. East of Gr.	Date	Decl. Local Mean Time	Decl. Value	Incl. L. M. T.	Incl. Value	Hor. Int. L. M. T.	Hor. Int. Value	Mag'r	Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Kalene Hill	11 11.0 S	24 12	Jun 9, '20	12.8,14.2	11 35.7 W	8.6	43 49.5 S	13.1,13.9	.24450	13	177.4X	FB
Broken Hill	14 28.1 S	28 26	Jul 9, 20	12.8,14.4	12 05.8 W	11.0	48 59.6 S	13.3,14.1	.22908	13	177.4X[2]	FB
Mburuma	15 36.2 S	29 40	Jul 31, 20	10.6,11.9	12 00.5 W	16.2	50 09.9 S	11.0,11.6	.22530	13	177.2X(78)	FB
			Aug 1, 20	5.9 to 18.2 (dv)	11 59.7 W	....	....	....	....	13	....	FB
Feira	15 37.4 S	30 25	Aug 5, 20	10.8,11.7	11 50.6 W	15.9	50 25.3 S	10.7,11.4	.22566	13	177.2X(78)	FB
Kafue	15 46.6 S	28 12	Jul 20, 20	10.7,12.3	12 50.6 W	16.0	50 40.6 S	11.1,11.9	.22237	13	177.2X[1]	FB
			Jul 20, 20	....	....	17.3	50 40.4 S	....	....	.....	177.2X(78)	FB
Shapanga	15 51.1 S	29 07	Jul 28, 20	16.2,17.6	12 14.0 W	14.6	50 27.0 S	16.6,17.3	.22296	13	177.2X(78)	FB
Mbosa	15 54.8 S	28 40	Jul 26, 20	15.5,16.9	12 17.6 W	13.8	50 31.4 S	15.9,16.6	.22272	13	177.2X(78)	FB
Livingstone	17 51.2 S	25 52	Jul 14, 20	....	....	16.7	52 49.6 S	....	....	.....	177.4X	FB
			Jul 15, 20	6.0 to 18.1 (dv)	14 44.1 W	....	....	....	....	13	....	FB
			Jul 16, 20	6.6, 8.1	14 41.8 W	....	....	7.0, 7.8	.21054	13	....	FB
Victoria Falls	17 56.1 S	25 51	Jul 17, 20	....	....	10.8	53 08.4 S	....	....	.....	177.2X[1]	FB
			Jul 17, 20	14.1,15.5	14 38.0 W	16.8	53 10.0 S	14.4,15.2	.20966	13	177.2X[1]	FB
Bethlehem	28 13.9 S	28 17	Mar 30, 16	9.1,11.4	20 43.4 W	14.7	60 20.3 S	9.7,10.9	.17920	17	223.1356	HES
Upington	28 28 S	21 12	May 8, 16	10.0,12.0	24 10.8 W	15.4	59 16.0 S	10.6,11.5	.17882	17	223.1356	HES
			May 9, 16	7.9 to 16.8 (dv)	24 08.3 W	....	....	....	....	17	....	HES
Ginginhlovu	29 01.7 S	31 35	Mar 25, 16	10.2,12.3	20 02.1 W	15.7	62 08.7 S	10.8,11.7	.17140	17	223.1356	HES
			Mar 26, 16	7.0 to 18.1 (dv)	19 59.3 W	....	....	....	....	17	....	HES
Bloemfontein	29 07.2 S	26 12	Apr 2, 16	9.4,11.4	22 16.8 W	15.5	61 03.2 S	9.9,11.0	.17221	17	223.1356	HES
Durban	29 52.7 S	31 04	Mar 22, 16	14.5,17.1	20 31.0 W	....	....	15.6,16.7	.16639	17	....	HES
			Mar 23, 16	....	....	10.1	62 42.0 S	....	....	.....	223.1356	HES
Cape Town, *A*	33 56.1 S	18 29	Apr 9, 16	10.4,12.9	26 45.1 W	....	....	11.0,12.3	.17053	17	....	HES
			Apr 10, 16	....	....	8.2	60 50.6 S	....	....	.....	223.1356	HES
			Apr 30, 20	9.1,11.1	26 03.5 W	....	....	9.7,10.7	.16580	5	....	C VI
			Apr 30, 20	12.2,13.7	25 58.4 W	....	....	12.6,13.2	.16571	5	....	C VI
			May 3, 20	....	....	....	....	13.6,14.8	.16554	25	....	C VI
			May 4, 20	....	....	....	....	8.3, 9.7	.16576	25	....	C VI
			May 4, 20	....	....	....	....	11.1,11.9	.16560	25	....	C VI
			May 4, 20	13.4,14.9	25 58.3 W	....	....	13.8,14.5	.16549	25	....	C VI
			May 4, 20	15.3,15.5	25 57.3 W	....	....	....	....	25	....	C VI
			May 5, 20	8.6,10.3	26 03.8 W	14.3,14.9	61 29.1 S	9.2, 9.9	.16570	25	EI 7	C VI
			May 5, 20	11.0,11.3	26 03.6 W	15.4,15.7	61 29.9 S	....	....	5	EI 25	C VI
Cape Town, *C*	33 56.1 S	18 29	May 14, 16	11.1,16.4	26 48.3 W	....	....	13.3,15.4	.17058	17	....	HES
			May 15, 16	9.4	26 48.8 W	....	....	10.6	.17096	17	....	HES
			May 16, 16	8.7,11.9,12.5	26 48.5 W	....	....	9.8,11.2	.17104	17	....	HES
			May 16, 16	15.1,15.8	26 45.0 W	....	....	13.1,14.6	.17094	17	....	HES
			May 17, 16	....	....	9.7	60 46.4 S	....	....	.....	223.1356	HES

[1] 13X and 14X only. [2] 16X rejected. [3] 15X rejected.

AFRICA.

BRITISH SOUTH AND CENTRAL AFRICA—*Concluded*.

Station	Latitude	Long. East of Gr.	Date	Declination: Local Mean Time	Declination: Value	Inclination: L. M. T.	Inclination: Value	Hor. Intensity: L. M. T.	Hor. Intensity: Value	Instruments: Mag'r	Instruments: Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Cape Town, *C*—*Continued*.	33 56.1 S	18 29	Apr 30, '20	9.1,11.1	26 06.4 W	....	....	9.6,10.7	.16549	25	....	C VI
			Apr 30, 20	12.2,13.7	26 02.2 W	....	....	12.5,13.2	.16536	25	....	C VI
			May 4, 20	13.4,14.9	26 00.8 W	....	....	13.8,14.6	.16514	5	....	C VI
			May 4, 20	15.3,15.5	26 00.8 W	....	....	....	....	5	....	C VI
			May 5, 20	8.6,10.3	26 08.0 W	14.3,14.9	61 30.2 S	9.2, 9.9	.16552	5	EI 25	C VI
			May 5, 20	11.0,11.3	26 07.7 W	15.4,15.7	61 29.4 S	....	....	25	EI 7	C VI
			May 6, 20	15.3 to 16.8 (dv)	25 59.8 W	8.5 to 14.9 (8)	61 30.4 S	9.4,10.0	.16546	25	EI 25	C VI
			May 6, 20	....	....	....	....	12.8	.16529	25	....	C VI
			May 7, 20	7.9 to 9.8 (dv)	26 05.3 W	10.8,11.4	61 29.6 S	....	....	25	EI 25	C VI
			May 7, 20	....	....	12.3	61 29.3 S	....	....	......	EI 25	C VI
			May 12, 20	13.6 to 17.0 (dv)	25 59.8 W	....	....	....	....	25	....	C VI

CAMEROUN.

Station	Latitude	Long. East of Gr.	Date	Declination: Local Mean Time	Declination: Value	Inclination: L. M. T.	Inclination: Value	Hor. Intensity: L. M. T.	Hor. Intensity: Value	Instruments: Mag'r	Instruments: Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Ngala....................	12 20.6 N	14 10	Sep 6, '19	15.3,16.2	7 29.1 W	17.6	6 32.8 N	15.7	.33083	13	177.4X	FB
Dragh....................	12 16.7 N	14 54	May 2, 17	18.1	7 35.2 W	....	....	....	....	17	....	HES
			May 3, 17	7.1	7 28.8 W	8.5	6 26.0 N	5.9, 6.8	.33078	17	223.13	HES
Afado....................	12 14 N	14 37	Sep 8, 19	15.7,16.6	7 22.2 W	17.7	6 23.5 N	16.1	.33123	13	177.2X[1]	FB
Dikoa....................	12 01.7 N	13 54	Sep 3, 19	15.3,16.7	7 45.8 W	....	....	15.7,16.4	.33034	13	....	FB
			Sep 4, 19	....	....	7.0	6 05.1 N	....	....	......	177.4X	FB
Bama....................	11 31.6 N	13 41	Aug 31, 19	15.7,17.1	7 44.0 W	18.1	4 54.6 N	16.1,16.8	.33010	13	177.4X	FB
Douhou....................	10 46.9 N	13 26	Aug 27, 19	12.9,14.3	8 08.5 W	17.4	3 18.4 N	13.3,14.0	.32488	13	177.4X[2]	FB
Moubi....................	10 16.4 N	13 14	Aug 24, 19	7.7, 9.2	8 04.8 W	11.1	1 40.9 N	8.1, 8.8	.33034	13	177.4X	FB
Ssorao....................	9 44.7 N	13 15	Aug 21, 19	....	....	17.8	0 36.2 N	....	....	......	177.2X[3]	FB
			Aug 22, 19	6.4, 7.2	8 15.4 W	....	....	6.8	.32704	13	....	FB
Garoua, *B*....................	9 18.3 N	13 24	Aug 14, 19	15.6,17.1	8 19.2 W	13.9	0 18.9 S	16.0,16.8	.32662	13	177.4X	FB
			Aug 15, 19	5.8 to 18.1 (dv)	8 18.8 W	....	....	....	....	13	....	FB
Garoua....................	9 17.4 N	13 24	Jun 22, 14	14.4,16.5	8 58.2 W	....	....	15.2,16.0	.32730	20	....	HES
			Jun 23, 14	....	....	10.9	0 02.1 N	....	....	......	20.126	HES
			Aug 12, 19	10.8,12.7	8 20.0 W	15.5	0 18.7 S	11.2,12.2	.32649	13	177.4X[5]	FB
Lagdo....................	9 02.8 N	13 41	Aug 9, 19	13.4,15.0	8 14.9 W	17.3	1 09.6 S	13.8,14.6	.32636	13	177.4X	FB
Rei Bouba....................	8 40.0 N	14 10	Aug 7, 19	7.5, 9.1	8 11.4 W	11.1	1 58.1 S	7.9, 8.8	.32754	13	177.4X	FB
Ndium Ndunajum........	8 12.1 N	14 12	Aug 4, 19	13.0,14.3	8 42.2 W	16.7	3 17.1 S	13.3,14.0	.32874	13	177.4X	FB
Holdu....................	7 42.1 N	14 06	Jul 31, 19	15.0,16.5	8 22.2 W	17.7	4 05.8 S	15.4,16.2	.32584	13	177.4X	FB
			Aug 1, 19	8.8 to 18.1 (dv)	8 20.6 W	....	....	....	....	13	....	FB
Ngaoundere....................	7 18.6 N	13 29	Jul 25, 19	13.0,14.6	8 42.8 W	....	....	13.4,14.2	.32499	13	....	FB
			Jul 26, 19	....	....	9.5	5 06.7 S	....	....	......	177.4X	FB
Mancha....................	7 07.5 N	13 13	Jul 23, 19	10.2,11.7	8 44.6 W	16.1	5 43.8 S	10.6,11.3	.32295	13	177.4X	FB
Kaega-Matekel..............	6 48.0 N	13 07	Jul 21, 19	14.0,15.6	8 45.3 W	17.7	6 26.5 S	14.4,15.3	.32210	13	177.4X[4]	FB
Tibati....................	6 28.0 N	12 33	Jul 18, 19	15.0,16.6	9 00.7 W	....	....	15.5,16.3	.32162	13	....	FB
			Jul 19, 19	....	....	8.5	7 30.4 S	....	....	......	177.4X	FB
Boudjiri....................	6 03.7 N	12 28	Jul 16, 19	11.3,13.6,15.0	9 11.9 W	16.2	8 00.5 S	11.7,13.2	.32087	13	177.4X[4]	FB
Yoko....................	5 32.1 N	12 20	Jul 11, 19	....	....	16.0	9 15.6 S	....	....	......	177.4X	FB
			Jul 12, 19	8.0, 9.7	9 31.6 W	....	....	8.4, 9.3	.31568	13	....	FB
			Jul 13, 19	5.9 to 18.1 (dv)	9 33.2 W	....	....	....	....	13	....	FB
Mangal....................	5 12.4 N	12 12	Jul 9, 19	13.2,14.9	9 41.3 W	17.3	9 48.9 S	13.6,14.5	.31654	13	177.4X	FB
Nkongsamba..............	4 57.3 N	9 57	May 9, 19	14.8,16.3	9 59.7 W	11.2	10 16.2 S	15.2,16.0	.31655	13	177.4X[5]	FB
Nghila....................	4 43 N	11 42	Jul 6, 19	14.8,15.9	9 42.0 W	17.3	10 44.6 S	15.3	.31546	13	177.4X[5]	FB
Lum....................	4 42.6 N	9 45	May 10, 19	12.9,14.3	11 29.4 W	16.7	12 34.6 S	13.2,14.0	.31212	13	177.4X[6]	FB
Kompina....................	4 21.6 N	9 36	May 13, 19	16.3,17.8	10 44.4 W	....	....	16.7,17.5	.31088	13	....	FB
			May 14, 19	....	....	8.5,11.0	11 17.2 S	....	....	......	177.4X[6]	FB
Sanaga....................	4 21.0 N	11 39	Jul 4, 19	10.9,13.3	9 55.4 W	16.8	11 48.3 S	11.3,13.0	.31465	13	177.4X	FB
Douala....................	4 02.4 N	9 43	Apr 29, 15	8.1, 9.3	11 25.2 W	11.0	11 18.8 S	8.4, 9.0	.31279	16	222.1256	DMW
			May 3, 19	16.3,17.8	10 49.8 W	15.2	11 53.7 S	16.7,17.5	.31120	13	177.4X[5]	FB
Douala, *B*....................	4 02.4 N	9 43	May 5, 19	9.7,11.3	10 49.4 W	14.9	11 52.6 S	10.1,10.9	.31164	13	177.4X[5]	FB
			Jan 20, 20	10.6,11.8	10 46.8 W	14.7	11 57.9 S	10.9,11.6	.31209	13	177.4X[5]	FB
Atok....................	4 01.6 N	12 47	Dec 17, 19	....	....	16.8	12 56.7 S	....	....	......	177.4X[5]	FB
			Dec 18, 19	7.0	9 29.8 W	....	....	6.5	.31157	13	....	FB
Abong-Mbang..............	3 59.7 N	13 12	Dec 16, 19	13.7,15.1	9 33.6 W	17.0	12 53.2 S	14.1,14.8	.31299	13	177.4X	FB
Yaounde....................	3 51.3 N	11 32	Jun 28, 19	9.4,13.5	10 01.7 W	15.9	12 58.2 S	9.9,13.2	.31079	13	177.2X[3]	FB
			Jun 30, 19	....	....	9.8	13 01.6 S	....	....	......	177.4X	FB
			Jul 1, 19	6.4 to 18.1 (dv)	10 00.9 W	....	....	....	....	13	....	FB
Edea....................	3 47.7 N	10 08	May 16, 19	9.2,10.9	11 04.6 W	14.4	13 04.0 S	9.7,10.6	.30970	13	177.4X	FB
Akonolinga..............	3 46.2 N	12 15	Dec 20, 19	7.0, 8.7	9 59.9 W	16.4	13 23.3 S	7.4, 8.2	.31048	13	177.4X	FB
Eseka....................	3 39.1 N	10 47	Jan 15, 20	6.1 to 18.1 (dv)	9 20.0 W	....	....	....	....	13	....	FB
			Jan 16, 20	6.5, 8.0	9 19.9 W	11.0	12 45.2 S	6.9, 7.7	.30954	13	177.4X	FB
Doumo....................	3 37.7 N	13 26	Dec 14, 19	16.9	9 25.7 W	16.0	13 43.1 S	17.3	.31068	13	177.4X[5]	FB

[1] 13X and 14X only. [2] 16X rejected. [3] 15X and 16X only. [4] 15X rejected. [5] 13X rejected. [6] 14X rejected.

AFRICA.

CAMEROUN—*Concluded.*

Station	Latitude	Long. East of Gr.	Date	Declination		Inclination		Hor. Intensity		Instruments		Obs'r
				Local Mean Time	Value	L. M. T.	Value	L. M. T.	Value	Mag'r	Dip Circle	
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Olama	3 25.5 N	11 16	Jun 23, '19	8.7,10.3	10 16.8 W	14.6	13 58.8 S	9.1,10.0	.30585	13	177.4X	FB
			Dec 31, 19	10.2,11.6	10 11.0 W	16.8	14 01.8 S	10.6,11.3	.30600	13	177.4X	FB
			Jan 1, 20	5.9 to 18.2 (dv)	10 10.7 W	....	....	....	....	13	....	FB
Lomié	3 09.5 N	13 41	Dec 11, 19	....	....	16.8	15 20.5 S	....	....	......	177.4X[1]	FB
			Dec 12, 19	8.5, 9.9	10 21.0 W	....	....	8.9, 9.6	.30930	13	....	FB
Kribi	2 56.4 N	9 55	Jun 9, 19	9.4,11.1	11 02.1 W	15.7	14 37.4 S	9.8,10.7	.30523	13	177.4X[2]	FB
Ebolowa	2 54.4 N	11 09	Jun 19, 19	8.6,10.3	10 16.4 W	14.3	15 00.7 S	9.0, 9.9	.30760	13	177.4X	FB
Efulen	2 47.4 N	10 32	Jun 13, 19	15.5,17.0	10 48.8 W	....	....	15.9,16.7	.30868	13	....	FB
			Jun 14, 19	6.0 to 18.1 (dv)	10 47.2 W	....	....	....	....	13	....	FB
			Jun 15, 19	....	....	15.5	14 37.6 S	....	....	......	177.4X	FB
Teisan	2 41.0 N	14 03	Dec 8, 19	12.8,14.3	10 03.8 W	16.6	15 50.1 S	13.2,14.0	.30776	13	177.4X	FB
Campo (Eclipse)	2 20.8 N	9 50	May 24, 19	18.0 to								
			May 25, 19	18.1 (dv)	11 07.1 W	....	....	....	....	13	....	FB
			May 26, 19	15.2,17.0	11 07.0 W	13.9	15 34.2 S	15.6,16.6	.30318	13	177.4X	FB
			May 28, 19	10.4 to 17.4 (dv)	11 06.8 W	....	....	....	....	13	....	FB
			May 29, 19	10.2 to 17.4 (dv)	11 08.8 W	....	....	....	....	13	....	FB
			May 30, 19	10.1 to 17.4 (dv)	11 08.7 W	....	....	....	....	13	....	FB
			May 31, 19	7.5, 9.2	11 04.4 W	13.7	15 36.1 S	8.0, 8.8	.30410	13	177.4X	FB
			Jun 1, 19	5.9 to								
			Jun 2, 19	6.2 (dv)	11 07.1 W	....	....	....	....	13	....	FB

CYRENAICA.

Station	Latitude	Long. East of Gr.	Date	Decl. L. M. T.	Decl. Value	Incl. L. M. T.	Incl. Value	H. I. L. M. T.	H. I. Value	Mag'r	Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Marsa Susa	32 54.5 N	21 58	Feb 8, '14	10.5,16.8	4 58.5 W	14.9	45 43.4 N	....	....	10	202.1257	WFW
			Feb 9, 14	11.6	4 58.6 W	....	....	10.3,11.1	.28284	10	....	WFW
Derna	32 45.6 N	22 39	Feb 15, 14	10.8 to 17.2 (dv)	4 42.7 W	....	....	....	....	10	....	WFW
			Feb 16, 14	11.3,16.3	4 42.7 W	....	....	13.6,14.6	.28391	10	....	WFW
			Feb 17, 14	....	....	11.0	45 27.6 N	....	....	......	202.1257	WFW
Tolmetta	32 43.9 N	20 56	Jan 29, 14	10.5,16.5	5 13.6 W	....	....	14.6,15.5	.28355	10	....	WFW
			Feb 1, 14	....	....	14.8	45 27.6 N	....	....	......	202.1257	WFW
Tobruk	32 06.0 N	23 57	Feb 21, 14	....	....	14.9	44 26.0 N	10.2,11.1	.28762	10	202.1257	WFW
			Feb 24, 14	10.6,11.5	4 17.4 W	....	....	....	....	10	....	WFW
			Feb 24, 14	14.7,16.8	4 18.2 W	....	....	....	....	10	....	WFW
Bengasi	32 05.2 N	20 06	Jan 20, 14	11.3,15.0	5 22.0 W	....	....	13.3,14.3	.28445	10	....	WFW
			Jan 21, 14	13.0 to 16.3 (dv)	5 22.9 W	11.7	44 53.6 N	....	....	10	202.1257	WFW
			Jan 22, 14	10.1 to 16.3 (dv)	5 22.0 W	....	....	....	....	10	....	WFW

EGYPT.

Station	Latitude	Long. East of Gr.	Date	Decl. L. M. T.	Decl. Value	Incl. L. M. T.	Incl. Value	H. I. L. M. T.	H. I. Value	Mag'r	Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Barrani	31 37.4 N	25 56	Apr 30, '14	9.0,11.1,16.7	3 33.4 W	14.7	43 39.7 N	9.8,10.6	.28888	10	202.1257	WFW
Sellum	31 34.3 N	25 10	May 3, 14	17.2	3 52.2 W	....	....	17.8	.28859	10	....	WFW
			May 4, 14	8.8,11.0	3 50.9 W	15.0	43 35.4 N	9.5,10.5	.28885	10	202.1257	WFW
Negeiyila	31 29.4 N	26 40	Apr 27, 14	9.2,11.2,16.6	3 35.9 W	14.7	43 30.0 N	9.8,10.7	.29203	10	202.1257	WFW
Matruh	31 22.8 N	27 16	Apr 23, 14	11.4,16.3	3 18.8 W	14.5	43 18.0 N	10.0,10.9	.29234	10	202.1257	WFW
Alexandria	31 16.4 N	30 00	Mar 7, 14	....	....	16.6	42 57.1 N	....	....	......	202.1257	WFW
			Mar 8, 14	10.7,13.0	2 32.4 W	....	....	11.6,12.4	.29428	10	....	WFW
			Mar 8, 14	14.3,16.3	2 33.0 W	....	....	....	....	10	....	WFW
Alexandria, *Secondary*	31 16.4 N	30 00	Mar 9, 14	10.4,13.1,16.7	2 33.3 W	15.3	42 56.9 N	11.3,12.5	.29438	10	202.1257	WFW
Rail Head	31 08.8 N	27 46	Apr 19, 14	8.1,16.8	3 16.7 W	14.8	42 51.4 N	9.7,10.6	.29428	10	202.1257	WFW
Daba	31 02.6 N	28 29	Apr 15, 14	8.8 to 17.4 (dv)	3 01.3 W	....	....	....	....	10	....	WFW
			Apr 16, 14	8.5,16.5	2 59.7 W	14.6	42 33.3 N	10.3,11.1	.29503	10	202.1257	WFW
El Omeiyid	30 48.4 N	29 14	Apr 13, 14	11.3,17.8,18.2	2 43.5 W	15.7	42 14.4 N	10.0,10.8	.29507	10	202.1257	WFW
Barrage	30 12.5 N	31 10	Mar 20, 14	15.9	2 18.4 W	13.9	41 08.6 N	....	....	10	202.1257	WFW
			Mar 21, 14	10.5,13.1,15.3	2 19.1 W	....	....	11.2,12.4	.29990	10	....	WFW
Suez	29 57.9 N	32 33	May 19, 14	17.8	1 55.2 W	....	....	17.1	.30167	10	....	WFW
			May 20, 14	9.5,11.5,16.6	1 56.7 W	14.2	40 49.4 N	10.1,11.0	.30192	10	202.1257	WFW
			May 20, 14	....	....	....	....	15.9	.30188	10	....	WFW
			Aug 28, 18	8.8,10.2	1 22.0 W	11.4	41 08.0 N	9.2, 9.9	.30096	17	223.1356	HES
Suez, *Secondary*	29 57.9 N	32 33	May 21, 14	9.5,11.8	1 56.3 W	14.2	40 49.4 N	10.4,11.3	.30203	10	202.1257	WFW
Helwan Observatory, *N*	29 51.6 N	31 20	Mar 13, 14	15.4,17.4	2 10.2 W	....	....	15.9,16.8	.30012	10	....	WFW
			Mar 14, 14	9.0,11.0,16.5	2 10.0 W	....	....	9.5,10.4	.30032	10	....	WFW
			Jul 12, 18	17.2,18.4	1 36.6 W	....	....	17.6,18.1	.29924	17	....	HES
			Jul 19, 18	10.2,11.6	1 37.2 W	....	....	10.7,11.3	.29980	17	....	HES
			Jul 19, 18	16.7,18.0	1 38.0 W	....	....	17.0,17.6	.29948	17	....	HES

[1] 15X rejected. [2] 14X rejected.

AFRICA.

EGYPT—*Concluded.*

Station	Latitude	Long. East of Gr.	Date	Declination: Local Mean Time	Declination: Value	Inclination: L. M. T.	Inclination: Value	Hor. Intensity: L. M. T.	Hor. Intensity: Value	Instruments: Mag'r	Instruments: Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Helwan Observatory, *S.*	29 51.6 N	31 20	Mar 14, '14			12.3,15.5	40 50.1 N				202.1257	WFW
			Jul 14, 18			17.8	41 06.0 N				223.1356	HES
			Jul 15, 18			16.4	41 07.1 N				223.1356	HES
			Jul 24, 18			17.4	41 06.0 N				223.1356	HES
Helwan Observatory, *H.*	29 51.6 N	31 20	Mar 12, 14	9.5,12.1,12.6	2 12.7 W	16.0	40 51.2 N	10.4,11.4	.30005	10	202.1257	WFW
			Mar 13, 14	9.3,11.4	2 11.0 W	12.6	40 49.0 N	9.8,10.7	.30020	10	202.1257	WFW
			Jul 12, 18	8.5, 9.9	1 35.5 W			8.9, 9.5	.29936	17		HES
			Jul 12, 18	10.9,12.5	1 39.0 W			11.3,11.9	.29955	17		HES
			Jul 14, 18			16.5	41 07.1 N				223.1356	HES
			Jul 15, 18			18.1	41 07.0 N				223.1356	HES
			Jul 19, 18	8.3, 9.6	1 35.4 W			8.7, 9.3	.29938	17		HES
			Jul 26, 18	9.0	1 32.8 W			9.4,10.0	.29922	17		HES
Tor	28 14.4 N	33 36	Sep 2, 18	7.4, 9.0	1 05.9 W	10.0	38 19.5 N	7.9, 8.6	.30880	17	223.1356	HES
Luxor	25 43 N	32 39	Jul 8, 18	7.9, 9.6	1 47.3 W	18.4	34 12.1 N	8.3, 9.2	.31848	17	223.1356	HES
Khattara	24 13 N	32 53	Jul 4, 18	9.4,11.0	1 53.6 W	17.9	31 02.8 N	9.8,10.7	.32450	17	223.1356	HES

ERITREA.

Station	Latitude	Long. East of Gr.	Date	Declination: Local Mean Time	Declination: Value	Inclination: L. M. T.	Inclination: Value	Hor. Intensity: L. M. T.	Hor. Intensity: Value	Instruments: Mag'r	Instruments: Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Massaua	15 36.2 N	39 27	Oct 7, '14	15.6,16.2	1 20.2 W					10		WFW
			Oct 8, 14	10.4,13.6	1 21.0 W	15.4	12 58.1 N	10.9,13.1	.34831	10	202.1257	WFW
			May 19, 18	8.4,10.0	0 57.0 W	10.9	13 26.2 N	8.9, 9.7	.34766	17	223.1356	HES
Agordat	15 32 N	37 54	May 9, 18	13.4	1 21.0 W	16.4	13 11.8 N	13.8	.34737	17	223.13	HES
Asmara	15 21.0 N	38 56	Oct 4, 14	10.5,14.0	1 27.2 W			11.0,13.2	.34810	10		WFW
			Oct 5, 14	8.5	1 24.3 W	10.0	12 14.9 N			10	202.1257	WFW
			May 14, 18	15.4,17.1	0 49.6 W			16.0,16.8	.34804	17		HES
			May 16, 18			7.8	12 48.1 N				223.1356	HES
			May 17, 18	8.3	0 54.4 W					17		HES
Adi Caieh	14 51.3 N	39 23	Sep 26, 14	10.1,13.6	1 29.0 W	15.8	11 07.0 N	10.7,12.6	.34929	10	202.1257	WFW

FRENCH EQUATORIAL AFRICA.

Station	Latitude	Long. East of Gr.	Date	Declination: Local Mean Time	Declination: Value	Inclination: L. M. T.	Inclination: Value	Hor. Intensity: L. M. T.	Hor. Intensity: Value	Instruments: Mag'r	Instruments: Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Am Raya	14 08.1 N	16 32	Jun 9, '17	5.5, 8.3	6 49.8 W	11.1	10 35.9 N	6.2, 7.9	.33336	17	223.1356	HES
Mao	14 07.7 N	15 19	May 16, 17	7.4, 9.9	7 07.0 W			8.2, 9.5	.33260	17		HES
			May 17, 17	6.2 to 18.0 (dv)	7 08.5 W					17		HES
			May 19, 17			7.9	10 48.3 N				223.1356	HES
Goudjour	14 01.9 N	15 38	May 30, 17	9.0,11.3	7 07.6 W	15.6	10 31.7 N	9.5,10.8	.33289	17	223.1356	HES
Haraze	13 57.4 N	19 33	Jul 12, 17	14.3,16.5	6 10.8 W			14.8,16.1	.33524	17		HES
			Jul 13, 17			11.1	9 52.5 N				223.1356	HES
N'Galo Billani	13 54.3 N	15 49	Jun 1, 17	8.4,10.6	7 05.9 W	15.3	10 18.2 N	9.1,10.2	.33309	17	223.1356	HES
Keliganga	13 52.3 N	15 04	May 12, 17	8.2,10.2	6 57.4 W	16.1	11 08.2 N	8.7, 9.8	.32778	17	223.1356	HES
Affoughly	13 50.1 N	20 00	Jul 16, 17	5.9 to 18.5 (dv)	6 08.4 W					17		HES
			Jul 17, 17	9.7,11.6	6 05.8 W	16.3	9 45.9 N	10.3,11.2	.33592	17	223.1356	HES
Abeché	13 49 N	20 51	Jul 25, 17	10.2,11.8	5 45.7 W			10.6,11.4	.33708	17		HES
			Jul 26, 17			7.7	9 25.6 N				223.1356	HES
			Jul 28, 17	6.2 to 18.2 (dv)	5 45.6 W					17		HES
Mourra	13 47.8 N	21 13	Jul 31, 17	8.0, 9.9	5 54.8 W	15.2	8 32.8 N	8.5, 9.5	.33649	17	223.1356	HES
Abou Tibené	13 47.6 N	19 08	Jul 9, 17	16.4,18.4	6 14.6 W			17.0,18.1	.33477	17		HES
			Jul 10, 17			8.9	9 38.3 N				223.1356	HES
Mussak	13 47.4 N	20 21	Jul 19, 17	7.9, 9.5	5 57.6 W	14.8	9 30.3 N	8.4, 9.2	.33726	17	223.1356	HES
Deuguelba	13 46.6 N	16 12	Jun 3, 17	5.6 to 17.9 (dv)	7 00.7 W					17		HES
			Jun 4, 17	5.8, 9.7	6 56.6 W	17.2	9 55.9 N	8.4, 9.4	.33334	17	223.1356	HES
Tountouma	13 44.5 N	22 02	Aug 8, 17	14.4,17.0	5 39.4 W			14.8,16.6	.33517	17		HES
			Aug 9, 17			10.7	9 24.9 N				223.1356	HES
Bir Taouil	13 43.4 N	21 43	Aug 4, 17	7.6, 9.8	5 18.6 W	14.4	9 14.6 N	8.1, 9.4	.33391	17	223.1356	HES
Moussou Morra	13 39.1 N	16 33	Jun 13, 17	6.1, 8.1	6 54.8 W	17.3	9 29.7 N	6.7, 7.6	.33400	17	223.1356	HES
Roumbou	13 29.8 N	18 43	Jul 5, 17	5.8 to 18.6 (dv)	6 20.4 W					17		HES
			Jul 6, 17	8.0,11.7	6 16.8 W			8.8,11.4	.33553	17		HES
			Jul 7, 17			8.8	8 47.1 N				223.1356	HES
Bol	13 27.4 N	14 43	May 8, 17	5.9, 8.1	7 26.7 W	17.7	9 15.4 N	6.4, 7.6	.33242	17	223.1356	HES
Hadjilidié	13 22.9 N	17 00	Jun 18, 17	5.9 to 18.2 (dv)	6 52.8 W					17		HES
			Jun 19, 17	9.0,11.7	6 51.6 W	16.0	8 51.8 N	9.5,11.4	.33399	17	223.1356	HES
Ati	13 12.8 N	18 27	Jul 2, 17	7.4, 9.1	6 28.4 W	16.2	8 26.3 N	7.9, 8.8	.33450	17	223.1356	HES
Djidodo	13 07.6 N	18 02	Jun 28, 17	8.0,10.2	6 32.1 W	17.2	8 03.1 N	8.4, 9.9	.33480	17	223.1356	HES
Diamené	13 06.7 N	17 25	Jun 22, 17	6.0, 8.8	6 45.7 W	17.2	8 06.0 N	7.1, 8.4	.33474	17	223.1356	HES

AFRICA.

FRENCH EQUATORIAL AFRICA—*Continued.*

Station	Latitude	Long. East of Gr.	Date	Declination: Local Mean Time	Declination: Value	Inclination: L. M. T.	Inclination: Value	Hor. Intensity: L. M. T.	Hor. Intensity: Value	Instruments: Mag'r	Instruments: Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Abakatal	13 06.5 N	17 42	Jun 24, '17	17.2	6 45.9 W			17.8,18.6	.33362	17		HES
			Jun 25, 17	7.8	6 40.4 W	9.3	8 09.3 N			17	223.1356	HES
Mani	12 43.8 N	14 41	May 4, 17	6.0, 7.7	7 24.9 W	8.9	7 53.0 N	6.5, 7.3	.33244	17	223.13	HES
Fort Lamy, *C*	12 06.7N	15 02	Sep 16, 19	7.3, 8.8, 9.0	7 16.5 W	14.9	6 07.8 N	7.6, 8.5	.33206	13	177.4X	FB
Fort Lamy, *A*	12 06.6 N	15 02	Apr 26, 17	6.2, 7.8	7 34.3 W			6.6, 7.5	.33324	17		HES
			Apr 27, 17			7.2	6 14.7 N				223.1356	HES
			May 1, 17	5.8 to 17.5 (dv)	7 36.4 W					17		HES
			Sep 13, 19			16.8	6 10.6 N				177.4X	FB
			Sep 14, 19	13.9,15.4	7 18.6 W			14.3,15.1	.33266	13		FB
			Sep 15, 19	5.9 to 18.1 (dv)	7 17.0 W					13		FB
Fort Lamy, *B*	12 06.6 N	15 02	Sep 12, 19			16.5	6 09.8 N				177.4X	FB
			Sep 13, 19	6.5, 8.0	7 17.0 W			6.9, 7.7	.33242	13		FB
Milé	11 43.4 N	15 20	Apr 18, 17	11.5,15.6,17.5	7 29.8 W	16.6	5 14.5 N	10.3,11.0	.33222	17	223.1356	HES
Logone Gana	11 33.9 N	15 09	Sep 23, 19	6.2, 7.8	7 14.9 W	11.3	4 34.7 N	6.6, 7.4	.33148	13	177.4X[1]	FB
Mogroum	11 06.8 N	15 24	Apr 15, 17	6.0 to 18.0 (dv)	7 35.2 W					17		HES
			Apr 16, 17	7.8, 9.8	7 34.6 W	11.1	3 44.4 N	8.3, 9.4	.33064	17	223.1356	HES
Mousgoum	10 55.0 N	15 07	Sep 27, 19	9.1,10.7	7 31.5 W	14.4	3 20.5 N	9.6,10.4	.33184	13	177.4X	FB
Baleiniere	10 50.0 N	15 44	Apr 12, 17	13.6,15.2	7 39.8 W	16.9	3 02.1 N	14.1,14.9	.33175	17	223.1356	HES
Ninth Encampment North of Fort Archambault	10 42.4 N	16 16	Apr 10, 17	15.5,17.3	7 27.0 W			16.1,17.0	.33202	17		HES
			Apr 11, 17			6.7	2 32.9 N				223.1356	HES
Sixth Encampment North of Fort Archambault	10 29.0 N	17 06	Apr 6, 17	8.8,10.6	7 09.2 W	14.1	1 28.9 N	9.3,10.3	.33162	17	223.1356	HES
Bousso	10 28 N	16 43	Apr 8, 17	9.4,15.8	7 28.0 W	17.6	1 56.9 N	14.7,15.5	.33204	17	223.1356	HES
Bongor	10 17.4 N	15 25	Oct 1, 19	13.4,15.0	7 33.2 W	17.1	1 41.6 N	13.8,14.6	.33144	13	177.4X	FB
			Oct 2, 19	5.8 to 18.1 (dv)	7 30.2 W					13		FB
Miltou	10 13.2 N	17 28	Apr 4, 17	16.4,18.2	7 06.0 W			16.9,17.9	.33120	17		HES
			Apr 5, 17			9.2	1 38.3 N				223.1356	HES
Djimmane	9 53.1 N	15 50	Oct 6, 19	6.2, 7.6	7 24.8 W	10.5	0 23.0 N	6.6, 7.3	.33008	13	177.4X	FB
Niom	9 47.4 N	17 48	Apr 1, 17	14.0,15.5	6 54.6 W	17.3	0 17.5 N	14.5,15.2	.33150	17	223.1356	HES
			Apr 2, 17	6.6 to 17.9 (dv)	6 55.6 W					17		HES
Second Encampment North of Fort Archambault	9 24.6 N	18 10	Mar 30, 17			17.9	0 36.8 S				223.1356	HES
			Mar 31, 17	8.6,10.1	7 08.0 W			9.0, 9.8	.33330	17		HES
Lai	9 23.7 N	16 18	Oct 9, 19			17.4	0 13.9 S				177.4X	FB
			Oct 10, 19	7.2, 8.7	7 04.8 W			7.6, 8.4	.32926	13		FB
Fort Archambault	9 08.9 N	18 26	Mar 13, 17	10.6,12.0	7 11.1 W			11.0,11.7	.33415	17		HES
			Mar 14, 17			7.4	1 01.2 S				223.1356	HES
			Mar 15, 17	6.7 to 18.0 (dv)	7 12.4 W					17		HES
Moyo Combo	8 53.6 N	18 43	Mar 5, 17	6.8, 8.9	7 02.0 W	10.1	2 07.8 S	7.8, 8.6	.33336	17	223.1356	HES
Doba	8 39.0 N	16 53	Oct 14, 19	6.7, 8.2	7 27.1 W	15.5	2 16.4 S	7.1, 7.9	.33058	13	177.4X[2]	FB
Irena	8 34.3 N	19 06	Mar 2, 17	10.2,11.5	6 48.1 W	15.5	2 51.5 S	10.6,11.2	.32986	17	223.1356	HES
			Mar 3, 17	6.2 to 17.8 (dv)	6 49.4 W					17		HES
Beguekai	8 02.1 N	16 13	Oct 19, 19	10.2,11.3	7 42.8 W	14.2	3 43.4 S	10.5,11.1	.32822	13	177.4X	FB
Goré	7 55.7 N	16 38	Oct 17, 19	10.1,11.4	7 45.2 W	16.6	4 08.8 S	10.5,11.2	.32870	13	177.4X	FB
Lito, *A*	7 54.0 N	19 02	Feb 27, 17	8.6,10.5	6 52.2 W			9.1,10.2	.33024	17		HES
Lito, *B*	7 54.0 N	19 02	Feb 27, 17			14.6	4 23.9 S				223.1356	HES
Baibokoum	7 44.6 N	15 44	Oct 22, 19	12.7,14.2	8 03.0 W	16.5	4 43.4 S	13.1,13.8	.32615	13	177.4X[1]	FB
			Oct 23, 19	15.3	8 05.1 W			15.6	.32608	13		FB
Second Encampment North of Fort Crampel	7 30.2 N	19 03	Feb 25, 17	8.2, 9.6	6 59.2 W	10.8	5 29.1 S	8.6, 9.3	.32986	17	223.1356	HES
Lim	7 17.0 N	15 32	Oct 25, 19			17.1	5 20.0 S				177.4X[1]	FB
			Oct 26, 19	6.6, 7.9	8 05.1 W			6.9, 7.6	.32549	13		FB
Fort Crampel	6 59.0 N	19 12	Feb 21, 17	9.3,11.2	6 58.8 W	17.4	7 52.1 S	9.8,10.9	.32983	17	223.1356	HES
Iki	6 41.5 N	19 07	Feb 18, 17	9.6,11.4	7 39.5 W	15.5	8 53.4 S	10.1,11.1	.32262	17	223.1356	HES
Gama	6 30.4 N	15 38	Oct 29, 19	8.1, 9.6	8 09.2 W	10.8	7 18.7 S	8.5, 9.3	.32280	13	177.4X[1]	FB
Dekoa	6 18.5 N	19 08	Feb 14, 17	9.8	7 35.1 W					17		HES
			Feb 15, 17	6.6 to 17.8 (dv)	7 35.8 W					17		HES
			Feb 16, 17	7.8, 9.4	7 34.4 W	11.0	10 07.5 S	8.2, 9.0	.31492	17	223.1356	HES
La Bassinda	5 59.7 N	19 10	Feb 12, 17	8.3,10.8	6 32.2 W	16.3	8 23.2 S	8.9,10.5	.32021	17	223.1356	HES
Bouar	5 56.6 N	15 35	Oct 31, 19	14.6,16.0	8 13.9 W	17.1	8 43.6 S	14.9,15.7	.32222	13	177.4X	FB
			Nov 1, 19	5.8 to 15.4 (dv)	8 13.1 W					13		FB
			Nov 1, 19	16.5 to 18.2 (dv)	8 14.5 W					13		FB
Fort Sibut	5 43.0 N	19 06	Feb 2, 17	7.4 to 17.6 (dv)	7 05.3 W					17		HES
			Feb 4, 17	8.1,10.0	7 04.1 W	17.3	10 10.6 S	8.7, 9.7	.32138	17	223.1356	HES
Bi River	5 38.4 N	18 51	Jan 30, 17	14.5,16.5	7 43.0 W			14.8,15.9	.32027	17		HES
			Jan 31, 17			8.5	9 57.9 S				223.1356	HES
Boudei	5 38.3 N	15 49	Nov 3, 19	15.6,16.4	8 18.0 W	17.4	9 42.7 S	15.9	.32101	13	177.4X	FB
Diouma	5 21.0 N	18 43	Jan 28, 17	10.0,11.8	8 10.0 W			10.5,11.3	.31914	17		HES
			Jan 29, 17			8.6	10 39.7 S				223.1356	HES
Damara	4 58.0 N	18 42	Jan 25, 17	8.9,10.5	7 39.6 W	16.1	11 09.1 S	9.4,10.1	.31778	17	223.1356	HES

[1] 13X rejected. [2] 15X rejected.

AFRICA.

FRENCH EQUATORIAL AFRICA—*Continued.*

Station	Latitude	Long. East of Gr.	Date	Declination		Inclination		Hor. Intensity		Instruments		Obs'r
				Local Mean Time	Value	L. M. T.	Value	L. M. T.	Value	Mag'r	Dip Circle	
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Carnot	4 56.4 N	15 53	Nov 6, '19	....	....	17.3	11 43.4 S	....	....	....	177.4X[1]	FB
....	....	....	Nov 7, 19	7.2, 8.5	7 31.4 W	....	....	7.6, 8.2	.32144	13	....	FB
Djoumba	4 40.4 N	18 34	Jan 23, 17	8.5,10.6	7 55.2 W	16.2	11 32.9 S	9.4,10.3	.31652	17	223.1356	HES
Baboko	4 34.4 N	16 08	Nov 9, 19	6.6, 8.0	7 31.0 W	10.9	12 55.3 S	7.0, 7.7	.31602	13	177.4X	FB
Kana	4 29 N	18 29	Jan 21, 17	13.9,15.6	8 06.3 W	17.0	11 56.3 S	14.4,15.3	.31670	17	223.1356	HES
Bangui	4 21.5 N	18 35	Dec 26, 16	8.7,10.7	8 09.5 W	15.2	12 31.4 S	9.3,10.3	.31664	17	223.1356	HES
			Dec 27, 16	6.8 to 17.5 (dv)	8 08.4 W	....	....	....	....	17	....	HES
			Jan 3, 17	....	....	14.6	12 26.1 S	....	....	....	223.1356	HES
			Jan 13, 17	6.9 to 17.7 (dv)	8 07.3 W	....	....	....	....	17	....	HES
Bania	3 59.8 N	16 08	Nov 10, 19	....	....	16.9	13 59.0 S	....	....	....	177.4X[2]	FB
			Nov 11, 19	7.1, 8.5	8 40.2 W	....	....	7.5, 8.2	.31074	13	....	FB
Nola, *A*	3 31.4 N	16 04	Nov 13, 19	13.0,14.4	7 45.4 W	16.3	14 16.4 S	13.3,14.1	.31058	13	177.4X	FB
			Nov 14, 19	5.8 to 17.9 (dv)	7 45.8 W	....	....	....	....	13	....	FB
			Nov 15, 19	7.4	7 46.3 W	....	....	....	....	13	....	FB
Nola, *B*	3 31.4 N	16 04	Nov 15, 19	....	....	10.8	14 10.8 S	....	....	....	177.4X	FB
			Nov 16, 19	6.8, 8.2	7 47.3 W	....	....	7.2, 7.9	.31106	13	....	FB
Bayanga	2 54.4 N	16 16	Nov 17, 19	12.9,14.2	8 37.6 W	16.2	15 28.1 S	13.2,13.9	.30802	13	177.4X	FB
Bomassa	2 12.4 N	16 13	Nov 19, 19	8.4, 9.8	9 19.5 W	15.5	16 17.5 S	8.8, 9.5	.30854	13	177.4X	FB
Souanke	2 04.1 N	14 09	Dec 5, 19	9.2,10.5	9 39.2 W	14.5	17 18.3 S	9.5,10.2	.30550	13	177.4X[1]	FB
Moloundu	2 02.3 N	15 14	Nov 27, 19	....	....	16.7	17 14.2 S	....	....	....	177.4X[1]	FB
			Nov 28, 19	6.0, 7.5	8 50.6 W	....	....	6.5, 7.2	.30606	13	....	FB
Ngoila	2 01.3 N	14 55	Nov 29, 19	7.2, 8.6	9 17.2 W	13.5	17 28.8 S	7.6, 8.3	.30524	13	177.4X[1]	FB
Sembé	1 38.8 N	14 36	Dec 2, 19	5.9 to 15.8 (dv)	9 56.3 W	17.1	18 40.7 S	....	....	13	177.4X	FB
			Dec 3, 19	6.4, 7.8	9 56.2 W	....	....	6.8, 7.5	.30092	13	....	FB
Ouesso	1 36.9 N	16 04	Nov 22, 19	8.0, 9.9	9 20.4 W	13.9	19 10.6 S	8.4, 9.6	.30290	13	177.4X[2]	FB
Libreville, *A*	0 23.2 N	9 27	Oct 3, 16	12.8,15.2	12 22.7 W	....	....	13.4,14.4	.29733	17	....	HES
			Oct 4, 16	....	....	8.2	19 30.3 S	....	....	....	223.1356	HES
			Jan 27, 20	7.3, 8.7	12 00.7 W	16.9	19 54.7 S	7.7, 8.4	.29700	13	177.4X[2]	FB
Libreville, *B*	0 23.2 N	9 27	Oct 4, 16	12.0,14.3	12 36.2 W	15.8	19 17.5 S	12.6,13.8	.29842	17	223.1356	HES
Chinchoua	0 00.6 N	9 46	Sep 24, 16	8.6,10.6	12 13.4 W	15.3	20 29.4 S	9.2,10.1	.29572	17	223.1356	HES
Boué	0 05 S	11 57	Aug 29, 16	9.3,11.4	11 39.4 W	17.2	21 25.2 S	9.9,11.1	.29359	17	223.1356	HES
Junckville	0 07 S	11 08	Sep 4, 16	....	....	16.5	20 41.2 S	....	....	....	223.1356	HES
			Sep 5, 16	6.2 to 9.6(dv)	11 57.9 W	....	....	14.0,14.8	.29560	17	....	HES
			Sep 5, 16	13.1,15.2	11 59.1 W	....	....	....	....	17	....	HES
			Sep 6, 16	6.6 to 17.1 (dv)	12 00.3 W	....	....	....	....	17	....	HES
Ivindo	0 09.2 S	12 10	Aug 26, 16	10.0,14.5,16.5	11 44.6 W	....	....	15.0,16.1	.29384	17	....	HES
			Aug 27, 16	....	....	10.3	22 06.4 S	....	....	....	223.1356	HES
Ndjolé	0 10.8 S	10 48	Sep 9, 16	15.1,16.8	12 08.4 W	....	....	15.7,16.5	.29506	17	....	HES
			Sep 10, 16	....	....	7.7	20 58.5 S	....	....	....	223.1356	HES
Ayemé	0 15 S	9 56	Sep 21, 16	13.0,15.0	12 32.0 W	....	....	13.6,14.6	.29457	17	....	HES
			Sep 22, 16	....	....	8.8	21 03.8 S	....	....	....	223.1356	HES
Massanza	0 25.4 S	10 29	Sep 13, 16	6.7, 8.3	12 07.8 W	14.2	21 27.0 S	7.2, 7.9	.29414	17	223.1356	HES
Missoko	0 37 S	12 30	Aug 23, 16	9.0,10.8	11 41.0 W	13.4	22 21.7 S	9.6,10.5	.29418	17	223.1356	HES
Lambarené	0 42 S	10 15	Sep 16, 16	6.3 to 17.0 (dv)	12 29.3 W	....	....	....	....	17	....	HES
			Sep 17, 16	14.0,17.1	12 28.4 W	....	....	14.6,15.6	.29392	17	....	HES
			Sep 18, 16	....	....	10.3	22 02.0 S	....	....	....	223.1356	HES
Port Gentil (Cape Lopez), *1915*	0 42.6 S	8 46	Apr 16, 15	14.2,15.9	13 22.0 W	....	....	14.5,15.4	.29110	16	....	DMW
			Apr 18, 15	....	....	15.2	21 23.5 S	....	....	....	222.1256	DMW
			Oct 7, 16	9.6,11.8	13 08.4 W	13.4	21 39.0 S	10.2,11.1	.29106	17	223.1356	HES
			Oct 8, 16	6.3 to 17.5 (dv)	13 07.3 W	....	....	....	....	17	....	HES
Port Gentil (Cape Lopez), *1920*	0 42.6 S	8 46	Jan 31, 20	10.9,12.7	12 42.3 W	16.1	22 03.1 S	11.2,11.8	.29068	13	177.4X	FB
Lastourville	0 48.2 S	12 44	Aug 18, 16	9.1,11.4	11 34.7 W	14.9	22 58.6 S	9.7,10.9	.29404	17	223.1356	HES
			Aug 19, 16	6.5 to 17.6 (dv)	11 32.1 W	....	....	....	....	17	....	HES
			Aug 21, 16	....	....	7.9	23 00.1 S	....	....	....	223.1356	HES
Boukoussou	1 07.1 S	13 12	Aug 15, 16	16.4,16.8	11 37.7 W	....	....	14.8,15.9	.29112	17	....	HES
			Aug 16, 16	....	....	8.0	23 49.8 S	....	....	....	223.1356	HES
M'Boma	1 23.0 S	13 20	Aug 14, 16	9.9,12.6	11 32.6 W	13.9	23 59.7 S	10.8,11.9	.29070	17	223.1356	HES
Franceville	1 38.0 S	13 36	Aug 11, 16	15.8,17.4	11 41.1 W	....	....	16.3,17.1	.28971	17	....	HES
			Aug 12, 16	....	....	11.3	24 27.2 S	....	....	....	223.1356	HES
Ouala	1 58.8 S	13 55	Aug 8, 16	6.6, 8.5	11 33.8 W	9.6	25 26.4 S	7.3, 8.1	.28928	17	223.1356	HES
N'Gobo	2 04.4 S	14 15	Aug 4, 16	10.0,11.8	11 37.6 W	15.2	25 38.3 S	10.6,11.4	.28900	17	223.1356	HES
Djambani	2 13.2 S	14 30	Jul 30, 16	10.1,11.8	11 37.6 W	16.0	26 06.6 S	10.6,11.5	.28847	17	223.1356	HES
			Jul 31, 16	6.4 to 17.5 (dv)	11 38.2 W	....	....	....	....	17	....	HES
M'Pala	2 13.3 S	15 10	Jul 25, 16	9.2,11.2	11 21.2 W	13.6	25 59.7 S	9.7,10.8	.28868	17	223.1356	HES
Djambala	2 33.0 S	14 44	Jul 22, 16	11.4,15.8	11 32.7 W	17.0	26 45.8 S	14.3,15.3	.28638	17	223.1356	HES
Itinsi	2 57.2 S	14 38	Jul 19, 16	9.9,14.1	11 46.2 W	15.5	27 30.7 S	10.4	.28459	17	223.1356	HES
Pangala	3 18.6 S	14 31	Jul 15, 16	7.0 to 17.6 (dv)	11 58.9 W	....	....	....	....	17	....	HES
			Jul 16, 16	7.5, 9.5	11 57.3 W	16.3	28 08.3 S	8.1, 9.1	.28196	17	223.1356	HES
Mayama	3 50.8 S	14 53	Jul 11, 16	9.4,11.8	12 21.8 W	15.0	29 14.5 S	10.2,11.3	.28050	17	223.1356	HES
Boukiero	4 11.5 S	15 18	Nov 22, 16	15.1	12 24.2 W	....	....	15.5	.27911	17	....	HES

[1] 13X rejected. [2] 15X rejected.

AFRICA.

FRENCH EQUATORIAL AFRICA—*Concluded.*

Station	Latitude	Long. East of Gr.	Date	Declination		Inclination		Hor. Intensity		Instruments		Obs'r
				Local Mean Time	Value	L. M. T.	Value	L. M. T.	Value	Mag'r	Dip Circle	
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Brazzaville	4 17.0 S	15 17	Nov 29, '14	10.4,11.9	12 42.8 W	....	....	10.8,11.5	.27979	16	....	DMW
			Nov 30, 14	....	....	7.0	30 01.2 S	....	....	......	222.1256	DMW
			Jun 20, 16	7.6 to 17.2 (dv)	12 28.2 W	....	....	....	....	17	....	HES
			Jun 21, 16	10.3,14.0	12 28.8 W	15.5	30 11.0 S	11.2,12.2	.27915	17	223.1356	HES
			Jul 2, 16	6.5 to 17.8 (dv)	12 28.5 W	....	....	....	....	17	....	HES
			Nov 18, 16	13.4,14.9	12 25.8 W	....	....	13.9,14.6	.27887	17	....	HES
Loango	4 38.4 S	11 48	Apr 9, 15	15.5,17.4	13 43.8 W	....	....	17.7,18.2	.27536	16	....	DMW
			Apr 10, 15	14.1,15.2	13 43.8 W	8.0	29 47.4 S	14.4,14.9	.27586	16	222.1256	DMW

FRENCH SOMALILAND.

Station	Latitude	Long. East of Gr.	Date	Decl. L. M. T.	Decl. Value	Incl. L. M. T.	Incl. Value	Hor. Int. L. M. T.	Hor. Int. Value	Mag'r	Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Jibuti	11 34.2 N	43 08	Jun 7, '14	9.8,10.2,16.8	1 15.3 W	15.0	3 59.6 N	10.8,13.0	.35204	10	202.1257	WFW
			Sep 22, 18	7.2, 8.8	0 48.7 W	9.8	4 26.2 N	7.6, 8.4	.35100	17	223.1356	HES

FRENCH WEST AFRICA.

Station	Latitude	Long. East of Gr.	Date	Decl. L. M. T.	Decl. Value	Incl. L. M. T.	Incl. Value	Hor. Int. L. M. T.	Hor. Int. Value	Mag'r	Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Conakry	9 30.8 N	346 16	Feb 26, '14	8.8,13.1,14.9	18 37.8 W	16.7	14 58.4 N	9.3, 9.6	.28273	16	222.1256	DMW
			Feb 26, 14	....	....	....	....	13.6,14.5	.28204	16	....	DMW
Bouaké	7 42 N	354 58	Jan 27, 14	8.8,10.8	16 04.4 W	15.0	3 40.8 N	9.4,10.4	.31461	20	20.126	HES
Palime	6 54.4 N	0 39	Mar 11, 14	9.5,12.6	14 05.1 W	16.5	1 22.9 S	9.8,10.9	.31573	20	20.126	HES
Dimbokro	6 38.5 N	355 12	Jan 24, 14	15.1,17.5	16 10.4 W	....	....	15.8,17.0	.31137	20	....	HES
			Jan 25, 14	....	....	11.5	1 09.2 N	....	....	......	20.126	HES
Lome	6 07.4 N	1 16	Mar 5, 14	8.7,12.1	14 02.4 W	15.9	3 23.3 S	9.5,10.9	.31336	20	20.12	HES
Abidjan	5 19.1 N	356 00	Jan 31, 14	7.9, 9.7	16 22.7 W	10.9	1 49.5 S	8.5, 9.4	.30954	20	20.126	HES
Grand Bassam	5 11.8 N	356 19	Jan 19, 14	9.0,11.4	16 21.2 W	16.6	2 30.1 S	9.9,11.0	.31038	20	20.126	HES

GOLD COAST COLONY.

Station	Latitude	Long. East of Gr.	Date	Decl. L. M. T.	Decl. Value	Incl. L. M. T.	Incl. Value	Hor. Int. L. M. T.	Hor. Int. Value	Mag'r	Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Kpandu	6 59.9 N	0 18	Mar 8, '14	11.5	14 12.3 W	....	....	14.8	.31578	20	....	HES
			Mar 9, 14	8.8	14 13.6 W	11.8	0 50.3 S	8.3	.31575	20	21.126	HES
Kumasi	6 41.0 N	358 26	Feb 10, 14	15.8	15 02.0 W	....	....	....	....	20	....	HES
			Feb 11, 14	7.6, 9.7	15 02.7 W	12.1	0 40.8 S	8.2, 9.1	.31412	20	20.126	HES
Dunkwa	5 57.5 N	358 15	Feb 8, 14	7.7, 9.5	15 20.6 W	13.6	2 14.8 S	8.2, 9.2	.31202	20	20.126	HES
Accra, *1914*	5 32.5 N	359 49	Feb 23, 14	9.4,11.6	14 40.8 W	16.8	3 48.9 S	10.0,11.1	.31094	20	20.126	HES
			Feb 26, 14	7.7 to 17.3 (dv)	14 39.7 W	....	....	....	....	20	....	HES
Accra, *1919*	5 32.5 N	359 49	Apr 26, 19	12.8,14.4	14 02.9 W	11.4	4 37.0 S	13.2,14.0	.30981	13	177.2X[1]	FB
Elmina, *A*	5 04.8 N	358 39	Feb 15, 14	8.3,10.1	15 22.8 W	16.6	4 20.0 S	8.7, 9.6	.31002	20	20.126	HES
Elmina, *B*	5 04.8 N	358 39	Feb 16, 14	8.8, 9.0	15 24.8 W	....	....	....	....	20	....	HES
Sekondi, *1914*	4 56.2 N	358 18	Feb 6, 14	8.1, 9.9	15 31.4 W	12.3	4 16.2 S	8.6, 9.6	.30946	20	20.126	HES
Sekondi, *1919*	4 56.2 N	358 18	Apr 25, 19	14.1	14 57.6 W	13.2	5 22.4 S	14.5	.30818	13	177.2X[1]	FB

LIBERIA.

Station	Latitude	Long. East of Gr.	Date	Decl. L. M. T.	Decl. Value	Incl. L. M. T.	Incl. Value	Hor. Int. L. M. T.	Hor. Int. Value	Mag'r	Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Cuttington*	4 22.7 N	352 19	May 17, '19	11.2,13.0,16.0	17 53.2 W	15.1,15.4	3 37.5 S	11.8,12.5	.30510	24	EI 24	B&J
Harper*	4 22.5 N	352 16	May 14, 19	15.4,17.4	17 28.2 W	12.2,12.5	2 36.3 S	16.0,17.0	.30434	24	EI 24	B&J
Cape Palmas, Russwurm Is*	4 21.6 N	352 16	Jan 12, 14	9.4,12.6	21 25.2 W	....	.. ....	10.5,11.6	.29694	20	....	HES
			Jan 13, 14	....	....	9.8	1 52.0 S	....	....	......	20.126	HES
			May 15, 19	11.0,13.0	21 14.2 W	16.1,16.6	3 04.4 N	11.7,12.6	.28905	24	EI 24	B&J

NIGERIA.

Station	Latitude	Long. East of Gr.	Date	Decl. L. M. T.	Decl. Value	Incl. L. M. T.	Incl. Value	Hor. Int. L. M. T.	Hor. Int. Value	Mag'r	Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Kano	12 00.9 N	8 33	May 1, '14	8.3	9 48.5 W	....	....	8.8 ..	.32716	20	....	HES
			May 2, 14	7.7,16.0,18.0	9 50.7 W	11.6	7 03.2 N	7.2 ..	.32681	20	20.126	HES
			May 2, 14	....	....	....	....	16.3,17.6	.32678	20	....	HES

* Local disturbance. [1] 13X and 16X only.

AFRICA.

NIGERIA—*Concluded.*

Station	Latitude	Long. East of Gr.	Date	Declination		Inclination		Hor. Intensity		Instruments		Obs'r
				Local Mean Time	Value	L. M. T.	Value	L. M. T.	Value	Mag'r	Dip Circle	
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Yale	11 42.4 N	13 42	Sep 1, '19	15.5,16.4	7 40.9 W	17.7	5 18.0 N	15.8	.32982	13	177.2 X[1]	FB
Zaria	11 06.8 N	7 43	May 5, 14	9.8,12.2	10 23.0 W	17.0	5 31.1 N	10.3,11.2	.32741	20	20.126	HES
Kaduna	10 29.2 N	7 25	Apr 26, 14	12.5,14.7 ..	10 39.2 W	....	....	13.0,14.2	.32558	20	....	HES
			Apr 27, 14	....	....	12.4	4 08.8 N	....	....	.....	20.126	HES
Bauchi	10 18.3 N	9 49	May 19, 14	8.2,10.5	9 49.8 W	15.1	3 25.9 N	8.8, 9.9	.32674	20	20.126	HES
Kwagal	10 16.9 N	10 37	May 26, 14	9.2,11.3	9 40.4 W	16.1	2 39.0 N	9.7,10.8	.32908	20	20.126	HES
Jenjere	10 14.5 N	8 50	May 9, 14	14.3,16.2	10 08.8 W	....	....	....	....	20	....	HES
			May 10, 14	10.5,12.4	10 09.1 W	....	....	11.0,11.9	.32648	20	....	HES
			May 11, 14	....	....	10.7	3 00.9 N	....	....	.....	20.126	HES
Debba Habe	10 12.8 N	11 24	May 31, 14	10.5,13.5	9 24.0 W	16.2	2 23.6 N	11.0,12.9	.32788	20	20.126	HES
Serikim Pawa	10 02.5 N	7 07	Apr 24, 14	10.2,12.7 ..	10 51.4 W	....	....	11.2,12.2	.32548	20	....	HES
			Apr 25, 14	7.0	10 49.1 W	8.6	3 05.6 N	....	....	20	20.126	HES
Shillem	9 53.4 N	12 03	Jun 6, 14	9.4,13.1	9 14.6 W	15.3	1 38.4 N	9.8,12.7	.32901	20	20.126	HES
Zungeru	9 48.5 N	6 10	Apr 15, 14	15.3,17.5	11 13.3 W	....	....	15.9,16.8	.32398	20	....	HES
			Apr 16, 14	....	....	16.3	2 59.0 N	....	....	.....	20.126	HES
Jimeta	9 16.7 N	12 29	Jun 12, 14	13.6,15.9	9 09.4 W	....	....	14.1,15.4	.32780	20	....	HES
			Jun 15, 14	....	....	17.3	0 00.2 N	....	....	.....	20.126	HES
			Jul 4, 14	5.8 to 14.5(dv)	9 08.4 W	....	....	....	....	20	....	HES
Lau	9 12.9 N	11 19	Jul 10, 14	10.6,13.7	9 32.4 W	15.6	0 18.2 N	11.1,13.1	.32748	20	20.126	HES
Jebba	9 07.7 N	4 49	Apr 10, 14	8.5,10.5	11 45.2 W	14.8	1 40.6 N	9.0,10.0	.32198	20	20.126	HES
Amar	8 40.9 N	10 23	Jul 15, 14	11.1,16.4	9 58.8 W	....	....	14.3,15.8	.32526	20	....	HES
			Jul 16, 14	....	....	10.2	0 49.3 S	....	....	.....	20.126	HES
Baro	8 37.0 N	6 23	Aug 28, 14	9.2,12.2	11 21.6 W	15.4	0 05.1 S	10.0,11.2	.32264	20	20.12(56)	HES
Ilorin	8 30.4 N	4 35	Apr 7, 14	13.1,15.5	12 05.3 W	....	....	13.7,15.0	.32072	20	....	HES
			Apr 8, 14	....	....	8.6	0 31.6 N	....	....	.....	20.126	HES
Ibi	8 10.8 N	9 44	Jul 20, 14	9.0,11.8	10 15.4 W	15.8	1 39.2 S	10.3,11.4	.32384	20	20.126	HES
			Jul 29, 14	9.5,11.5	10 14.0 W	14.0	1 38,9 S	10.0,10.9	.32348	20	20.12(56)	HES
Loko	7 59.8 N	7 50	Aug 12, 14	9.5,10.6	10 59.6 W	16.6	1 39.8 S	10.0,11.2	.32236	20	20.12(56)	HES
Lokoja	7 48.3 N	6 44	Aug 21, 14	8.8,11.5	11 28.9 W	15.0	1 39.5 S	9.5,10.9	.32314	20	20.12(56)	HES
			Aug 23, 14	8.0, 8.2	11 25.6 W	....	....	....	....	20	....	HES
			Sep 2, 14	12.5,14.4	11 27.8 W	....	....	12.9,14.0	.32292	20	....	HES
			Sep 3, 14	....	....	9.8	1 41.3 S	....	....	.....	20.12(56)	HES
Oshogbo	7 45.9 N	4 33	Apr 4, 14	14.4,16.4	12 26.8 W	11.0	1 16.3 S	15.1,16.0	.31988	20	20.126	HES
Abinsi	7 45.3 N	8 45	Aug 3, 14	8.6,10.8	10 43.8 W	15.0	2 35.9 S	9.3,10.3	.32228	20	20.12(56)	HES
Ibadan	7 23.2 N	3 53	Apr 2, 14	9.0,10.9	12 39.4 W	14.9	1 36.7 S	9.5,10.4	.31906	20	20.126	HES
Idah	7 06.4 N	6 43	Sep 14, 14	10.0,12.3	11 39.6 W	16.3	3 28.3 S	11.9	.31796	20	20.12(56)	HES
			Sep 15, 14	14.6,17.3	11 37.8 W	....	....	....	....	20	....	HES
			Sep 17, 14	6.9, 9.0	11 38.4 W	16.5	3 28.4 S	7.6, 8.6	.31776	20	20.12(56)	HES
Lagos, *A*	6 26.9 N	3 24	Mar 17, 14	9.8,12.7	13 04.3 W	15.4	3 43.2 S	10.6,12.0	.31618	20	20.126	HES
Lagos, *B*	6 26.9 N	3 24	Mar 22, 14	8.2,11.7	13 03.8 W	15.4	3 41.2 S	9.1,10.6	.31609	20	20.126	HES
Lagos, *C*	6 26.9 N	3 24	May 17, 15	13.6,15.2	12 56.5 W	11.1	3 47.3 S	13.9,14.7	.31522	16	222.1256	DMW
Onitsha	6 10.6 N	6 46	Sep 27, 14	12.8,14.8	11 50.0 W	....	....	13.3,14.4	.31662	20	....	HES
			Sep 28, 14	....	....	9.5	5 32.0 S	....	....	.....	20.12(56)	HES
Abo	5 32.0 N	6 33	Oct 2, 14	15.0,17.1	12 02.2 W	....	....	15.5,16.7	.31469	20	....	HES
			Oct 5, 14	....	....	10.1	6 57.0 S	....	....	.....	20.12(56)	HES
Forcados	5 22.9 N	5 22	Oct 30, 14	9.3,11.5	12 31.8 W	15.1	7 05.6 S	10.0,10.9	.31430	20	20.12(56)	HES

PORTUGUESE EAST AFRICA (MOZAMBIQUE).

Station	Latitude	Long. East of Gr.	Date	Decl. Local Mean Time	Decl. Value	Incl. L. M. T.	Incl. Value	Hor. Int. L. M. T.	Hor. Int. Value	Mag'r	Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Porto Amelia	12 58.3 S	40 30	Oct 11, '20	14.8,16.0	6 07.0 W	10.7	46 50.3 S	15.1,15.7	.24472	13	177.2X(78)[2]	FB
Mozambique, *A*	15 01.8 S	40 45	Oct 6, 20	9.2,10.6	7 05.9 W	15.5	50 00.5 S	9.6,10.3	.23150	13	177.2X(7)	FB
Mozambique, *B*	15 01.8 S	40 45	Oct 5, 20	10.3,11.8	7 01.4 W	9.3	49 55.5 S	10.7,11.5	.23159	13	177.2X(78)	FB
Chicoa	15 36.2 S	32 21	Aug 20, 20	14.0,15.6	10 45.6 W	10.6	50 17.6 S	14.6,15.3	.22518	13	177.2X(78)	FB
Panhame	15 37.2 S	30 40	Aug 12, 20	7.0, 8.3	11 29.2 W	11.2	50 39.6 S	7.3, 8.0	.22375	13	177.2X(78)[2]	FB
Cachomba	15 39.1 S	31 55	Aug 18, 20	10.2,11.6	10 37.6 W	14.8	50 26.7 S	10.6,11.3	.22478	13	177.2X(78)	FB
Captiva	15 43.7 S	31 14	Aug 14, 20	9.1,10.7	11 28.1 W	15.1	50 56.7 S	9.5,10.4	.22244	13	177.2X(78)	FB
			Aug 15, 20	5.8 to 18.1 (dv)	11 22.6 W	....	....	....	....	13	....	FB
Mashambo	15 45.3 S	32 53	Aug 23, 20	8.1, 9.5	10 45.6 W	15.8	50 31.6 S	8.5, 9.2	.22530	13	177.2X(78)	FB
Boroma	16 03.4 S	33 27	Aug 26, 20	9.2,10.6	10 19.5 W	14.2	51 15.3 S	9.6,10.3	.22115	13	177.2X(78)[2]	FB
Tete	16 09.2 S	33 35	Aug 30, 20	6.5, 7.9	10 21.5 W	16.4	51 10.9 S	6.9, 7.5	.22230	13	177.2X(78)	FB
			Sep 1, 20	5.7 to 18.1 (dv)	10 22.7 W	....	....	....	....	13	....	FB
Bandar	16 37.8 S	34 10	Sep 5, 20	....	....	17.1	52 06.5 S	....	....	.....	177.2X(78)	FB
			Sep 6, 20	7.4, 8.9	11 23.4 W	....	....	7.8, 8.6	.21838	13	....	FB
Ankuaze	16 47.6 S	34 34	Sep 7, 20	14.1,15.5	10 00.7 W	17.1	52 30.1 S	14.5,15.2	.21861	13	177.2X(78)	FB
Chemba	17 11.3 S	34 55	Sep 10, 20	8.0, 9.5	10 10.5 W	16.5	52 25.9 S	8.4, 9.2	.21841	13	177.2X(78)	FB
Chindio	17 41.6 S	35 17	Sep 13, 20	10.4,11.7	10 20.6 W	16.4	53 02.2 S	10.8,11.4	.21494	13	177.2X(78)	FB
			Sep 15, 20	5.9 to 18.1 (dv)	10 16.0 W	....	....	....	....	13	....	FB

[1] 13X and 14X only. [2] 13X rejected.

AFRICA.

PORTUGUESE EAST AFRICA (MOZAMBIQUE)—*Concluded.*

Station	Latitude	Long. East of Gr.	Date	Declination		Inclination		Hor. Intensity		Instruments		Obs'r
				Local Mean Time	Value	L. M. T.	Value	L. M. T.	Value	Mag'r	Dip Circle	
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Mopea	18 00.4 S	35 42	Sep 18, '20	7.2,14.0	10 32.6 W	10.7	53 47.8 S	7.6,13.7	.21230	13	177.2X(78)	FB
Chinde	18 34.6 S	36 28	Sep 21, 20	16.1,17.7	10 16.0 W	14.3	54 15.3 S	16.4,17.4	.20858	13	177.2X	FB
Beira, *A*	19 49.4 S	34 51	Sep 28, 20	10.0,11.5	12 01.1 W	13.2	55 31.6 S	10.4,11.2	.20330	13	177.2X(78)	FB
			Sep 28, 20	15.0	11 52.3 W	....	....	....	....	*177*	....	FB
Beira, *N*	19 49.4 S	34 51	Sep 28, 20	15.2	11 52.6 W	....	....	....	....	*177*	....	FB
Beira, *S*	19 49.4 S	34 51	Sep 28, 20	14.7	11 53.6 W	....	....	....	....	*177*	....	FB
Beira, *B*	19 49.9 S	34 51	Sep 29, 20	10.2,10.6	11 55.6 W	9.4	55 39.2 S	10.6,11.3	.20268	13	177.2X(78)	FB
Macute Point	19 51.0 S	34 53	Sep 30, 20	9.8,11.2	11 58.4 W	13.2	55 41.4 S	10.2,10.9	.20268	13	177.2X(78)	FB

SOUTHWEST AFRICA.

Station	Latitude	Long. East of Gr.	Date	Decl. L. M. T.	Decl. Value	Incl. L. M. T.	Incl. Value	Hor. Int. L. M. T.	Hor. Int. Value	Mag'r	Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Windhoek	22 33.8 S	17 05	Apr 25, '16	15.5,15.7	21 45.2 W	....	....	....	....	17	....	HES
			Apr 26, 16	9.7,11.9	21 50.8 W	15.2	54 06.6 S	10.5,11.4	.19746	17	223.1356	HES
Swakopmund	22 41.0 S	14 32	Apr 20, 16	13.8,15.9	22 31.4 W	....	....	14.3,15.5	.20008	17	....	HES
			Apr 21, 16	6.7 to 17.2 (dv)	22 30.6 W	....	....	....	....	17	....	HES
			Apr 22, 16	....	....	10.2	53 03.4 S	....	....	......	223.1356	HES
Gibeon	25 07.2 S	17 42	Apr 28, 16	9.1,10.8	23 02.0 W	13.3	56 12.7 S	9.5,10.4	.18908	17	223.136	HES
Keetmanshoop	26 34.7 S	18 04	Apr 30, 16	9.4,11.4	23 37.3 W	14.6	57 03.0 S	10.0,11.0	.18558	17	223.136	HES
Aus	26 40.3 S	16 12	May 4, 16	10.3,12.5	24 04.0 W	14.5	56 26.7 S	10.9,12.1	.18650	17	223.136	HES
Seeheim	26 48.5 S	17 44	May 1, 16	....	....	14.7	57 21.2 S	....	....	......	223.136	HES
			May 2, 16	9.5,12.0	23 56.9 W	....	....	10.3,11.6	.18459	17	....	HES

SPANISH GUINEA.

Station	Latitude	Long. East of Gr.	Date	Decl. L. M. T.	Decl. Value	Incl. L. M. T.	Incl. Value	Hor. Int. L. M. T.	Hor. Int. Value	Mag'r	Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Rio Campo	2 20.5 N	9 50	Jun 3, '19	8.8,10.3	11 07.8 W	14.1	15 35.8 S	9.2,10.0	.30432	13	177.4X	FB
Bata	1 52.5 N	9 45	Apr 27, 15	14.2,15.3	12 04.6 W	17.3	16 15.4 S	14.6,15.1	.30343	16	222.1256	DMW
Elobey	1 00.6 N	9 30	Apr 26, 15	12.8,13.9	12 21.2 W	15.9	18 05.2 S	13.1,13.7	.29882	16	222.1256	DMW

TRIPOLITANIA.

Station	Latitude	Long. East of Gr.	Date	Decl. L. M. T.	Decl. Value	Incl. L. M. T.	Incl. Value	Hor. Int. L. M. T.	Hor. Int. Value	Mag'r	Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Tripoli	32 53.9 N	13 11	Nov 4, '14	10.6,14.5,16.0	7 52.4 W	....	....	12.8,13.8	.27712	10	....	WFW
			Nov 5, 14	9.6,14.2	7 51.1 W	11.7	46 34.0 N	....	....	10	202.1257	WFW
Misurata	32 23.2 N	15 06	Jan 1, 14	10.0,16.0,16.4	7 03.6 W	....	....	10.6,11.4	.28138	10	....	WFW
			Jan 2, 14	11.9 to 16.1(dv)	7 05.3 W	9.9	45 37.7 N	....	....	10	202.1257	WFW
Syrte	31 12.6 N	16 33	Jan 6, 14	10.2,11.1	6 38.5 W	....	....	....	....	10	....	WFW
			Jan 7, 14	9.9	6 36.8 W	14.8	43 45.9 N	....	....	10	202.1257	WFW
			Jan 10, 14	....	....	....	....	15.4,16.3	.28702	10	....	WFW

UGANDA.

Station	Latitude	Long. East of Gr.	Date	Decl. L. M. T.	Decl. Value	Incl. L. M. T.	Incl. Value	Hor. Int. L. M. T.	Hor. Int. Value	Mag'r	Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Gondokoro	4 53.9 N	31 43	Mar 6, '18	10.2,11.9	4 29.6 W	14.8	12 16.9 S	10.8,11.6	.33116	17	223.1356	HES
Rejaf	4 44.1 N	31 38	Feb 23, 18	9.2,10.8	4 33.8 W	....	....	9.7,10.5	.33088	17	....	HES
			Feb 24, 18	7.0 to18.0 (dv)	4 33.7 W	....	....	....	....	17	....	HES
			Feb 25, 18	....	....	10.9	12 45.7 S	....	....	......	223.1356	HES

ASIA.

ARABIA.

Station	Latitude	Long. East of Gr.	Date	Declination		Inclination		Hor. Intensity		Instruments		Obs'r
				Local Mean Time	Value	L. M. T.	Value	L. M. T.	Value	Mag'r	Dip Circle	
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Jidda	21 28.3 N	39 11	Sep 6, '18	7.7, 9.3	0 23.8 W	10.5	26 06.3 N	8.2, 9.0	.33577	17	223.1356	HES
Aden*	12 47.1 N	44 59	Jun 3, 14	9.3,11.2,17.6	0 44.5 W	16.0	7 38.8 N	9.9,10.7	.35506	10	202.1257	WFW
			Sep 13, 18	7.2, 9.0	0 17.8 W	10.0	8 14.6 N	7.8, 8.6	.35454	17	223.1356	HES

CHINA.

Station	Latitude	Long. East of Gr.	Date	Decl. L. M. T.	Decl. Value	Incl. L. M. T.	Incl. Value	H. I. L. M. T.	H. I. Value	Mag'r	Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Manchouli	49 35.7 N	117 28	Sep 27, '16	12.6,15.1,17.4	5 56.8 W	10.0	67 26.5 N	13.4,14.6	.22182	9	177.235(3)	FB
			Sep 27, 16	....	....	....	....	17.0	.22139	9	....	FB
Hailar	49 13.7 N	119 45	Sep 24, 16	13.4,15.9	6 50.8 W	9.9	66 51.8 N	14.3,15.4	.22845	9	177.235(3)	FB
Buchedu	48 46.2 N	121 57	Sep 22, 16	13.4,15.7	7 36.3 W	10.7	66 44.7 N	14.0,15.2	.22562	9	177.235(3)	FB
Urga	47 55.6 N	106 52	Oct 25, 15	15.5	0 53.3 W	10.9	66 44.6 N	16.1	.22874	9	177.1256	FB
			Oct 25, 15	....	....	13.0	66 47.8 N	....	....	......	177.16	FB
			Oct 26, 15	11.2,13.6	0 55.8 W	....	....	11.8,13.0	.22890	9	....	FB
Jeerum	47 54.7 N	105 57	Nov 14, 15	13.8,16.4	0 30.4 W	10.8	66 41.0 N	14.5,15.8	.22997	9	177.1256	FB
			Nov 15, 15	12.8,13.1	0 30.6 W	....	....	13.7	.22984	9	....	FB
Tola Gol	47 42.4 N	105 05	Nov 18, 15	13.2,16.3	0 09.9 W	10.8	66 29.8 N	13.8,15.8	.23068	9	177.1256	FB
Booralchin Temple	47 22.3 N	107 44	Oct 16, 15	8.4, 8.7	1 19.4 W	10.6	66 07.8 N	13.8,14.8	.23355	9	177.1256	FB
			Oct 16, 15	13.3,15.3	1 16.6 W	....	....	....	....	9	....	FB
Tsitsihar	47 21.7 N	123 59	Sep 20, 16	15.9,18.1	7 34.0 W	9.4	64 26.5 N	16.5,17.6	.24202	9	177.135(3)	FB
Arra Hottock	47 17.0 N	104 41	Nov 21, 15	12.9,13.2,15.9	1 01.2 W	10.8	66 15.6 N	13.6,15.0	.23299	9	177.1256	FB
Tsitsihar Station	47 09.4 N	123 51	Sep 18, 16	15.5,17.8	7 52.6 W	....	....	16.2,17.3	.24314	9	....	FB
			Sep 19, 16	....	....	7.1	64 19.9 N	....	....	......	177.235(3)	FB
Hallchin Holer	46 52.5 N	108 50	Oct 12, 15	13.7,15.8	1 55.5 W	10.3	65 35.1 N	14.2,15.3	.23774	9	177.1256	FB
Goosut Ussu	46 52.0 N	103 47	Nov 25, 15	10.0,12.8	0 27.8 E	15.7	65 43.8 N	10.5,11.9	.23668	9	177.1256	FB
Boskhun Bollock	46 37.0 N	103 02	Nov 28, 15	13.2,13.5,16.5	0 46.0 E	10.7	65 30.8 N	14.0,16.0	.23820	9	177.1256	FB
Soolt Shunt Well	46 33.0 N	109 49	Oct 9, 15	13.9,16.3	2 27.2 W	10.7	65 14.3 N	14.6,15.8	.24206	9	177.1256	FB
Anda Station	46 24.8 N	125 20	Sep 29, 16	13.8,17.7	7 53.7 W	11.0	63 17.6 N	14.5,17.3	.24952	9	177.23(3)	FB
Chorkhurt-in Dava	46 17.4 N	102 35	Dec 1, 15	13.1,13.4,16.5	0 52.2 E	10.8	65 11.0 N	13.9,16.0	.24084	9	177.1256	FB
Eekhun Buyer Well	46 08.5 N	110 42	Oct 6, 15	9.8,14.6	2 32.8 W	16.5	64 25.4 N	10.9,13.9	.24710	9	177.1256	FB
Uhtergar Narin-in Gol	45 53.1 N	101 53	Dec 4, 15	13.2,16.2	0 58.0 E	10.6	64 46.4 N	13.6,15.6	.24350	9	177.1256	FB
Haragan Jeerum Well	45 48.1 N	111 19	Oct 3, 15	....	....	10.5	64 22.6 N	....	....	......	177.1256	FB
			Oct 3, 15	....	....	12.1	64 21.9 N	....	....	......	177.56	FB
			Oct 4, 15	10.1,11.5	2 48.5 W	....	....	10.7	.24695	9	....	FB
Harbin, *A*	45 44.0 N	126 43	Sep 14, 16	17.8,18.3	7 39.3 W	....	....	....	....	9	....	FB
			Sep 15, 16	5.8 to 18.4 (dv)	7 40.5 W	....	....	....	....	9	....	FB
			Sep 16, 16	7.8,10.4	7 40.2 W	14.1	62 15.8 N	8.4, 9.6	.25446	9	177.235(3)	FB
Harbin, *B*	45 44.0 N	126 43	Sep 17, 16	7.4,13.8	7 44.2 W	11.4	62 19.0 N	8.1,14.5	.25458	9	177.235(3)	FB
Hushurt-in Sire	45 34.8 N	101 08	Dec 7, 15	13.4,16.3	1 21.3 E	10.8	64 28.8 N	13.8,15.7	.24460	9	177.1256	FB
Imienpo	45 05.2 N	128 07	Oct 1, 16	13.5,17.2	7 33.8 W	10.9	61 20.8 N	14.1,16.7	.25913	9	177.23(3)	FB
Tarn-in Sire	44 57.5 N	101 05	Dec 10, 15	13.5,16 4	1 19.0 E	10.7	63 46.0 N	14.0,15.9	.25011	9	177.1256	FB
Choahr Ussu	44 33.4 N	101 30	Dec 13, 15	10.7,13.4	1 05.9 E	15.9	63 30.2 N	11.2,12.9	.25232	9	177.1256	FB
Olang Oobos Well	44 17.5 N	113 11	Sep 28, 15	10.6,13.3	3 45.8 W	8.6	62 31.5 N	11.1,13.8	.25918	9	177.1256	FB
			Sep 28, 15	....	....	15.5	62 31.7 N	....	....	......	177.12	FB
Kwangchengtze	43 56.3 N	125 21	Sep 6, 16	....	....	17.1	60 38.7 N	....	....	......	177.235(3)	FB
			Sep 7, 16	9.5,12.8	7 03.0 W	....	....	10.1,11.2	.26476	9	....	FB
			Sep 7, 16	....	....	....	....	13.3	.26483	9	....	FB
Olang Sire	43 53.3 N	102 17	Dec 17, 15	13.6,16.4	0 44.7 E	10.9	62 39.8 N	14.1,15.9	.25742	9	177.1256	FB
Kirin	43 51.0 N	126 36	Sep 9, 16	13.8,16.1	7 29.6 W	10.7	60 20.3 N	14.4,15.5	.26564	9	177.235(3)	FB
Fanchiatun	43 43.2 N	125 06	Sep 5, 16	9.0,11.6,14.0	7 04.0 W	15.4	60 31.5 N	9.8,11.0	.26570	9	177.235(3)	FB
Hushurt Hottock	43 32.1 N	102 59	Dec 20, 15	13.5	0 24.6 E	10.8	62 11.6 N	14.0,16.0	.26122	9	177.1256	FB
			Dec 21, 15	8.7	0 26.1 E	....	....	....	....	9	....	FB
Errin Gosso	43 24.4 N	112 56	Sep 24, 15	9.2, 9.4,11.6	3 28.3 W	14.4	61 36.4 N	10.0,11.0	.26487	9	177.1256	FB
			Sep 25, 15	8.9, 9.3	3 26.6 W	....	....	....	....	9	....	FB
Szepinkai	43 11.4 N	124 26	Sep 4, 16	8.9,11.2,11.5	8 08.6 W	14.6	60 14.1 N	9.6,10.8	.27182	9	177.235(3)	FB
Tayik Hyhun	43 04.9 N	103 32	Dec 23, 15	13.5,16.2	0 31.4 W	11.2	61 45.5 N	14.0,15.8	.26520	9	177.1256	FB
Gol Derris	43 00 N	113 18	Sep 21, 15	14.5,15.8	3 27.8 W	17.3	61 01.6 N	15.1	.26881	9	177.12	FB
Soom-in Bollock Camp	42 52.4 N	113 29	Sep 20, 15	13.5,15.6,16.0	3 31.0 W	10.8	60 54.9 N	14.1,15.2	.26908	9	177.1256	FB
Kaiyüan	42 33.2 N	124 05	Aug 31, 16	14.2,16.6	6 21.0 W	11.8	59 16.6 N	14.9,16.1	.27390	9	177.23	FB
			Aug 31, 16	....	....	18.3	59 18.0 N	....	....	......	177.5(3)	FB
			Sep 1, 16	5.8 to 18.1 (dv)	6 18.3 W	....	....	....	....	9	....	FB
Olang Dill Hottock	42 29.2 N	103 56	Dec 26, 15	13.3,16.3	0 04.8 W	11.4	61 07.7 N	13.8,15.8	.26792	9	177.12	FB
			Dec 27, 15	....	....	10.2	61 08.3 N	....	....	......	177.56	FB
Cholo Kobor	42 20.8 N	114 02	Sep 17, 15	13.9,15.8	3 41.2 W	17.6	60 31.3 N	14.4,15.4	.27181	9	177.1256	FB
Tiehling	42 19.4 N	123 54	Aug 30, 16	16.4,18.8	6 12.8 W	11.2	59 16.3 N	17.0,18.3	.27464	9	177.235(3)	FB
Dolon-nor	42 10 N	116 23	Sep 14, 15	9.6,11.5	2 25.2 W	14.8	60 34.0 N	10.3,11.1	.27212	12	206.12(56)	CKE
			Sep 15, 15	7.4 to 17.8 (dv)	2 24.6 W	....	....	....	....	12	....	INK
Sinminfu	41 59.6 N	122 52	Aug 19, 16	9.0,11.6	5 47.1 W	16.7	58 55.4 N	9.6,11.1	.27604	9	177.235(3)	FB

* Local disturbance.

ASIA.

CHINA—*Continued.*

Station	Latitude	Long. East of Gr.	Date	Declination		Inclination		Hor. Intensity		Instruments		Obs'r
				Local Mean Time	Value	L. M. T.	Value	L. M. T.	Value	Mag'r	Dip Circle	
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Gusson Togurik	41 52.1 N	103 57	Dec 29, '15	13.6,16.7	0 15.2 W	10.8	60 12.6 N	14.1,16.2	.27454	9	177.1256	FB
Moukden	41 49.7 N	123 28	Aug 15, 16	9.3 to 18.6 (dv)	6 08.2 W					9		FB
			Aug 16, 16	6.8 to 9.6 (dv)	5 59.8 W	12.2	58 37.6 N	16.6,17.8	.27763	9	177.23	FB
			Aug 16, 16	15.9,18.3	6 04.8 W					9		FB
			Aug 29, 16			8.1	58 41.3 N				177.235(3)	FB
Kuanti	41 48.3 N	116 54	Sep 18, 15	9.2,11.5	5 01.0 W	7.3	59 36.5 N	10.2,11.0	.27511	12	206.12(56)	CKE
Tabo Ol	41 45.1 N	114 08	Sep 13, 15	14.3	3 30.5 W	10.6	59 34.3 N	17.2	.27716	9	177.1256	FB
			Sep 14, 15	9.4,11.4	3 28.4 W			10.0,11.0	.27692	9		FB
Pingtinobo	41 41 N	115 39	Sep 10, 15			16.6	59 24.0 N				206.12(56)	CKE
			Sep 11, 15	10.0,11.9	3 47.1 W			10.6,11.4	.27698	12		CKE
Kowpangtze	41 22.0 N	121 44	Jul 19, 16	13.9,16.7	5 14.3 W	10.9	58 41.3 N	14.6,16.0	.27827	9	177.235(3)	FB
Panshantu	41 19.5 N	114 59	Sep 8, 15	10.6,12.6	3 40.4 W	17.5	59 15.0 N	11.2,12.1	.27822	12	206.12(5)	E&I
Liaoyang	41 17.0 N	123 13	Aug 22, 16	14.4,16.8	6 02.8 W			15.0,16.3	.27868	9		FB
			Aug 23, 16			10.0	58 09 4 N				177.235(3)	FB
Fengning	41 14 1 N	117 07	Sep 20, 15	14.7,16.3	4 43.9 W	17.8	58 45.6 N	15.1,15.8	.28018	12	206.12(56)	CKE
Shwangtaitze	41 12 3 N	122 02	Jul 20, 16			18.4	58 05.5 N				177.235(3)	FB
			Jul 21, 16	9.0,11.4	5 45.8 W			9.6,10.9	.28102	9		FB
Sokhontay-in Gol	41 11.0 N	104 13	Jan 1, 16	13.6,17.0	0 28.4 W	11.3	59 37.2 N	14.1,16.5	.27866	9	177.12	FB
Chinchowfu	41 09.3 N	121 09	Jul 17, 16			17.9	58 19.5 N				177.235(3)	FB
			Jul 18, 16	8.4,11.2	5 41.2 W			9.3,10.7	.28146	9		FB
Nanfen	41 06.2 N	123 47	Aug 12, 16	16.6,18.9	5 39.9 W	14.2	57 58.9 N	17.2,18.4	.27930	9	177.235(3)	FB
Chengtehfu	40 59 N	117 52	Sep 25, 15			16.5	58 16.7 N				206.12(56)	INK
			Sep 27, 15	10.3,11.9	4 14.2 W			10.9,11.6	.28519	12		CKE
Hsiung Wan Ku Tsun	40 56.0 N	107 49	May 5, 16	13.8,17.4	1 12.6 W	10.2	59 31.6 N	14.4,16.8	.27766	9	177.1256	FB
Tsaohokow	40 53.0 N	123 56	Aug 11, 16	8.8,11.3,11.6	7 19.9 W	14.8	57 53.4 N	9.4,10.7	.27832	9	177.235(3)	FB
Haicheng	40 51.5 N	122 47	Aug 24, 16	14.0,16.6	5 42.6 W	10.3	57 37.4 N	14.7,16.0	.28350	9	177.235(3)	FB
Kalgan	40 51 N	114 51	Sep 1, 15	12.1 to 15.5 (dv)	3 07.5 W					12		CKE
			Sep 2, 15	11.0,14.6	3 06.2 W	17.4	58 34.4 N	11.8,14.1	.28180	12	206.12	E&I
			Sep 3, 15			16.4	58 33.4 N				206.12(56)	INK
			Jun 7, 16	12.6,12.8,15.1	3 11.4 W	10.9	58 34.0 N	13.4,14.6	.28212	9	177.1256	FB
Patsebolong	40 50.9 N	108 37	May 10, 16			15.6	59 26.0 N				177.1256	FB
			May 11, 16	10.6,14.8	2 03.7 W			11.2,15.4	.27890	9		FB
Kweihwating	49 48.9 N	111 38	May 24, 16	13.4,13.7,15.9	2 40.5 W	10.9	58 50.0 N	14.3,15.5	.28351	9	177.1256	FB
Tchagan Toonke Hottock	40 46.3 N	104 31	Jan 4, 16	13.7,15.8	0 20.2 W	10.8	59 03.5 N	14.1,15.1	.28182	9	177.1256	FB
Niu Chüeh Chüan	40 41 N	112 28	May 27, 16	13.6,16.4	3 02.4 W	10.7	58 36.5 N	14.3,15.7	.28234	9	177.1256	FB
Newchwang	40 40.3 N	122 13	Jul 24, 16	14.4,16.8	5 27.6 W	10.8	57 49.9 N	15,1.16.3	.28258	9	177.235(3)	FB
Huangyang Motto	40 40.0 N	107 10	May 2, 16	9.2,11.5,17.3	1 04.6 W	15.0	58 46.8 N	9.8,11.0	.28263	9	177.256	FB
Ningyüanchow	40 38.1 N	120 42	Jul 14, 16	16.1,18.4	5 39.0 W			16.7,17.9	.28210	9		FB
			Jul 15, 16	5.9 to 18.1 (dv)	5 38.1 W					9		FB
			Jul 16, 16			10.7	57 51.4 N				177.25(3)	FB
Tao Ssu Ho	40 37.1 N	110 52	May 21, 16	13.9,16.6	2 31.1 W	10.5	58 18.2 N	14.6,15.9	.28721	9	177.1256	FB
Chahgar Tzu Tien	40 36.8 N	109 16	May 14, 16	13.8,15.9	2 00.7 W	11.3	58 24.2 N	14.4,15.5	.28708	9	177.256	FB
			May 14, 16			17.9	58 22.7 N				177.12	FB
Paotowchen	40 35.5 N	109 59	May 17, 16	15.8,17.1	1 59.0 W	11.3	58 49.6 N	17.7	.28456	9	177.12	FB
			May 18, 16	10.5	1 58.4 W	16.3	58 49.2 N	11.1	.28452	9	177.1256	FB
Fenghwangcheng	40 28.1 N	124 04	Aug 7, 16	16.0,16.2,18.6	6 01.2 W			16.9,18.1	.28492	9		FB
			Aug 8, 16			8.9	57 02.4 N				177.235(3)	FB
Tienchen	40 26.2 N	114 01	Jun 2, 16			18.2	58 02.1 N				177.1256	FB
			Jun 3, 16	8.3, 9.7	3 20.8 W			8.9	.28473	9		FB
Fengchen	40 25.4 N	113 06	May 30, 16	13.0,15.8	3 20.0 W	11.0	58 04.8 N	13.7,15.3	.28596	9	177.1256	FB
Shahokiao	40 20 N	118 13	Sep 29, 15	16.7,16.9	3 28.0 W	17.7	58 15.2 N			12	206.12	CKE
			Sep 30, 15					6.3, 7.0	.27728	12		CKE
Hokow	40 14.4 N	111 05	Jul 19, 16			17.6	58 08.7 N				206.12(56)	CKE
			Jul 20, 16	5.8, 7.7	2 39.8 W			6.3, 7.2	.28596	12		CKE
Nankow	40 14 N	116 09	Aug 30, 15	8.5,11.3	4 37.3 W	14.9	57 29.9 N	9.4,10.7	.29012	12	206.12(56)	CKE
Tsunhwachow	40 11 N	117 56	Oct 1, 15	8.1	3 09.7 W					12		INK
			Oct 1, 15	8.9 to 17.8 (dv)	3 12.0 W					12		INK
			Oct 2, 15	9.8,11.6	3 10.2 W	16.8	58 01.7 N	10.3,11.0	.28033	12	206.12(56)	E&I
Siongyocheng	40 10.7 N	122 08	Jul 25, 16			18.1	56 53.1 N				177.235(3)	FB
			Jul 26, 16	8.7,11.2	5 26.8 W			9.4,10.7	.28702	9		FB
Antung	40 09.3 N	124 23	Aug 5, 16	14.6,18.0	5 55.3 W	11.8	56 35.3 N	15.2,17.6	.28774	9	177.235(3)	FB
Illice-in Honkor Well	40 07.1 N	104 12	Jan 8, 16	13.6,17.1	0 17.2 W	11.2	58 14.2 N	14.1,16.4	.28504	9	177.1256	FB
Tatungfu	40 06.4 N	113 13	Jun 1, 16	13.2,15.6	3 30.5 W	11.0	57 45.6 N	13.8,15.1	.28684	9	177.1256	FB
Hungtuling	40 05.0 N	112 23	Jul 13, 16	18.0	2 49.4 W					12		CKE
			Jul 14, 16	6.5,11.2	2 46.4 W	13.1	57 52.0 N	7.3,10.6	.28706	12	206.12(56)	CKE
Tuanchialing	40 00.7 N	117 08	Oct 5, 15	10.8,11.6	4 06.2 W	7.0	57 27.7 N	10.2,11.0	.28634	12	206.12(56)	CKE
Shanhaikwan	39 58.3 N	119 45	Jul 13, 16	14.2,16.4	5 21.6 W	18.1	57 06.4 N	14.8,15.9	.28899	9	177.235(3)	FB
Peking, *1907*	39 56.6 N	116 25	Aug 20, 15	11.4,14.4	3 54.2 W	16.8	57 18.6 N	12.4,13.6	.28874	12	206.12(56)	CKE
			Oct 15, 15	8.6 to 17.0 (dv)	3 56.4 W					12		INK
Tongkow	39 55.9 N	106 43	Apr 27, 16	14.0,14.2,16.7	0 44.3 W	11.0	58 00.9 N	15.0,16.2	.28708	9	177.1256	FB
Tsingshuiho	39 54.8 N	111 39	Jul 17, 16	9.6,12.4,17.0	2 47.8 W	15.9	57 38.6 N	10.3,11.6	.28852	12	206.12(56)	CKE

ASIA.

CHINA—*Continued.*

Station	Latitude	Long. East of Gr.	Date	Declination		Inclination		Hor. Intensity		Instruments		Obs'r
				Local Mean Time	Value	L. M. T.	Value	L. M. T.	Value	Mag'r	Dip Circle	
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Tungchow	39 54.7 N	116 36	Oct 6, '15			16.2	57 15.1 N				206.12(56)	INK
			Oct 7, 15	11.4,13.9	3 58.6 W			14.6,15.5	.28849	12		CKE
			Oct 14, 15			14.6	57 15.9 N				206.12(56)	INK
Funinghsien	39 54.2 N	119 13	Jul 11, 16			18.0	56 51.4 N				177.235(3)	FB
			Jul 12, 16	7.2, 9.9,11.3	4 50.0 W			7.7,10.8	.28927	9		FB
Peking, *1916*	39 52.5 N	116 23	Jun 16, 16	14.0,16.2	4 09.6 W	10.9	57 09.2 N	14.6,15.8	.28936	9	177.1256	FB
Pehtaiho, *Rocky Point*	39 49.5 N	119 29	Jul 3, 16			15.4	56 59.0 N				177.1256	FB
			Jul 7, 16	10.2,12.6	4 24.0 W	15.4	56 57.6 N	11.0,12.2	.29046	9	177.235	FB
Pehtaiho, *A**	39 49.5 N	119 29	Oct 5, 16			15.7,17.3	57 04.0 N				177.23(3)	FB
			Oct 6, 16			9.9,10.2	57 06.5 N				177.23(3)	FB
			Oct 6, 16			12.1,15.2	57 06.3 N				206.12(56)	CKE
			Oct 6, 16			16.6	57 07.7 N				206.(56)	CKE
			Oct 7, 16			10.7	57 08.1 N				206.12(56)	CKE
			Oct 13, 16	15.1,17.4	3 40.8 W	11.4	57 07.1 N	15.7,16.9	.28915	9	206.12(56)	FB
			Oct 14, 16	6.4 to 18.3 (dv)	3 40.0 W					9		FB
Pehtaiho, *B**	39 49.5 N	119 29	Oct 5, 16			15.7,17.3	56 58.8 N				206.12(56)	CKE
			Oct 6, 16			9.9,10.2	57 01.3 N				206.12(56)	CKE
			Oct 6, 16			12.1,15.2	57 00.3 N				177.23(3)	FB
			Oct 6, 16			16.6	57 02.6 N				177.3(3)	FB
			Oct 7, 16			10.7	57 03.3 N				177.23(3)	FB
Wanghuo	39 49 N	113 57	Nov 1, 15	8.4 to 16.1 (dv)	3 13.3 W					12		INK
			Nov 2, 15	10.8,14.9	3 13.8 W	9.6	57 30.2 N	11.3,14.4	.29028	12	206.12(56)	CKE
Lwanchow	39 46.0 N	118 46	Jul 1, 16	9.9,14.1	4 39.4 W	7.4	56 44.8 N	10.6,13.4	.28948	9	177.1256	FB
Pekow	39 45 N	114 38	Oct 28, 15	16.0	3 31.9 W	14.9	57 16.8 N	16.6	.28984	12	206.12(56)	CKE
			Oct 29, 15	7.9	3 30.2 W			7.4	.28990	12		CKE
Hanshihling	39 40 N	114 39	Oct 27, 15	15.7,17.0	3 18.1 W	14.2	57 08.3 N	16.1,16.7	.29065	12	206.12(56)	CKE
Laoniuwan	39 38.6 N	111 19	Jul 24, 16	17.8	2 54.5 W			18.4,19.3	.28942	12		CKE
			Jul 25, 16	7.5, 7.8	2 49.6 W	5.8	57 21.9 N			12	206.12(56)	CKE
Tangshan	39 37 N	118 09	Aug 13, 15			18.1	56 50.0 N				206.12	CKE
			Aug 14, 15	6.8,11.0	4 32.1 W			8.5,10.3	.28995	12		CKE
Yingchow	39 33.7 N	113 10	Nov 5, 15	14.4,16.0	2 55.0 W			14.9,15.6	.28972	12		CKE
			Nov 6, 15			8.6	57 19.4 N				206.12(56)	CKE
Tuanyuantsun	39 32 N	114 41	Oct 26, 15	16.0,16.8	3 22.0 W	17.4	56 54.6 N	16.4	.29156	12	206.12	CKE
			Oct 27, 15			7.3	56 58.2 N				206.(56)	CKE
Pulantien	39 24.3 N	121 59	Jul 27, 16	8.8,11.6	5 00.8 W	14.2	56 20.7 N	9.4,11.1	.28952	9	177.235(3)	FB
Futuyü	39 22 N	114 51	Oct 25, 15	15.2,16.3	3 20.0 W	16.0	56 51.6 N	15.5,16.0	.29414	12	206.12	CKE
Liangkochwang	39 21 N	115 26	Oct 21, 15	14.5,15.9	3 52.0 W			14.9,15.6	.29336	12		CKE
			Oct 22, 15			10.5	56 39.1 N				206.12(56)	INK
Sochow	39 19.0 N	112 22	Nov 9, 15	9.8,12.4	2 23.4 W	15.8	57 20.2 N	10.9,11.8	.29049	12	206.12(56)	E&I
Kaopeitien	39 19 N	115 55	Oct 20, 15	16.8	3 18.3 W					12		CKE
			Oct 21, 15	7.7, 8.7	3 19.2 W	9.4	57 11.4 N	8.2	.28921	12	206.12	CKE
Hungmachia	39 18.5 N	103 51	Jan 13, 16	13.9,17.1	0 04.7 W	11.2	57 19.8 N	14.5,16.6	.29236	9	177.1256	FB
Shihtsuishan	39 13.8 N	106 46	Apr 24, 16	13.6,16.1	0 59.0 W	10.5	57 07.1 N	14.2,15.5	.29184	9	177.256	FB
Kinchow	39 07.4 N	121 43	Jul 28, 16	8.8,11.3,11.6	4 49.3 W	15.1	55 51.2 N	9.4,10.8	.29293	9	177.235(3)	FB
Tientsin	39 05.9 N	117 11	Jun 28, 16	14.4,17.3	4 03.8 W	10.6	56 21.2 N	15.0,16.4	.29314	9	177.1256	FB
Paotehchow	39 01.4 N	110 56	Nov 16, 15	8.4 to 16.5 (dv)	2 24.6 W					12		INK
			Nov 17, 15	13.3,15.2	2 18.2 W	10.7	58 31.9 N	14.0,14.7	.29384	12	206.12(56)	E&I
Shihtszkou	38 58 N	110 54	Jul 28, 16	5.6, 9.8	2 29.8 W			6.2, 9.3	.29472	12		CKE
Wüchai	38 55.2 N	111 45	Nov 12, 15	9.6,10.8	2 32.0 W	15.2	56 40.9 N	10.0,10.6	.29232	12	206.12(56)	CKE
Dairen	38 55.2 N	121 39	Jul 30, 16	17.0,18.6	5 05.6 W	14.7	55 34.3 N	17.7	.29455	9	177.235(3)	FB
Paotingfu	38 50.6 N	115 33	Oct 18, 15			16.9	56 17.4 N				206.12	INK
			Oct 19, 15	9.3,11.2	3 30.2 W	16.1	56 07.1 N	10.6	.29560	12	206.12(56)	E&I
			Oct 20, 15	9.8,11.2	3 31.7 W			10.2,10.8	.29526	12		CKE
Port Arthur	38 49.0 N	121 14	Jul 31, 16	15.0,17.4	5 02.2 W			15.8,17.0	.29484	9		FB
			Aug 1, 16	6.3 to 18.0 (dv)	5 01.1 W					9		FB
			Aug 2, 16			7.3	55 30.4 N				177.235(3)	FB
Haichalu	38 42.4 N	110 25	Nov 22, 15	8.9,10.5	1 53.4 W	13.4	56 26.3 N	9.4,10.1	.29408	12	206.12(56)	CKE
Chenfanhsien	38 37.5 N	103 16	Jan 17, 16	13.4,15.4	0 05.6 W	11.3	56 34.3 N	13.9,14.8	.29546	9	177.256	FB
			Jan 17, 16			16.9	56 33.5 N				177.56	FB
Encampment	38 33.1 N	110 00	Nov 24, 15	10.4,12.1	1 50.0 W	13.5	56 01.8 N	10.8,11.4	.29732	12	206.12	CKE
Ningsiafu	38 28.3 N	106 13	Apr 11, 16	13.0,15.4	0 54.4 W	11.2	56 11.9 N	13.6,14.8	.29708	9	177.1256	FB
			Apr 11, 16			17.4	56 13.3 N				177.26	FB
			Apr 12, 16	10.6 to 11.6 (dv)	0 53.1 W					9		FB
Liuchauwan	38 26.4 N	110 43	Jul 29, 16			18.0	56 18.5 N	14.2,17.2	.29565	12	206.12(56)	CKE
Tsangchow	38 17.7 N	116 58	Aug 27, 15	14.2,16.4,16.6	4 05.2 W			14.8,15.7	.29894	9		FB
			Aug 28, 15			7.1	55 23.0 N				177.1256	FB
Yulinfu	38 06 N	109 14	Nov 26, 15	9.9,11.9	2 09.3 W	14.0	55 44.2 N	10.4,11.3	.29884	12	206.12(56)	CKE
Liangchowfu	37 56.8 N	102 45	Jan 26, 16	15.4,17.4	0 07.4 E	11.8	55 30.6 N	16.0,16.9	.30007	9	177.125	FB
Liangchowfu, *Secondary*	37 55.4 N	102 44	Jan 24, 16	15.6	0 07.6 E			16.2,17.2	.30035	9		FB
			Jan 25, 16	14.5	0 05.3 E	11.0	55 32.1 N	15.0	.30026	9	177.1256	FB
			Jan 27, 16	11.1	0 06.3 E					9		FB

* Local disturbance.

ASIA.

CHINA—*Continued.*

Station	Latitude	Long. East of Gr.	Date	Declination: Local Mean Time	Declination: Value	Inclination: L. M. T.	Inclination: Value	Hor. Intensity: L. M. T.	Hor. Intensity: Value	Instruments: Mag'r	Instruments: Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Micheh	37 40.8 N	109 52	Nov 29, '15	13.8	2 01.7 W	10.4	55 11.3 N	16.5,17.2	.30204	12	206.12(56)	CKE
			Nov 30, 15	7.6	1 59.0 W	....	....	....	....	12	....	CKE
Chükopu	37 40.0 N	105 50	Apr 6, 16	13.9,16.3	0 50.2 W	10.6	55 07.2 N	14.4,15.7	.30278	9	177.1256	FB
Chikow	37 38.5 N	110 40	Aug 1, 16	6.4 to 17.8 (dv)	2 12.4 W	....	....	....	....	12	....	CKE
			Aug 2, 16	8.9,10.8	2 08.6 W	7.3	55 02.8 N	9.4,10.3	.30358	12	206.12(56)	CKE
Chungweihsien	37 30.6 N	105 08	Apr 3, 16	13.0,13.2,15.5	0 42.2 W	11.1	54 58.0 N	13.7,14.9	.30356	9	177.1256	FB
Suitehchow	37 29.8 N	110 02	Dec 1, 15	9.5 to 16.0 (dv)	1 56.5 W	....	....	....	....	12	....	INK
			Dec 2, 15	8.5, 9.9	1 56.1 W	11.1	54 53.8 N	8.9, 9.5	.30354	12	206.12(56)	CKE
Litsinghsien	37 29.5 N	118 19	Aug 19, 15	14.2,16.2	3 54.6 W	11.0	53 56.2 N	14.7,15.7	.30521	9	177.1256	FB
			Aug 19, 15	....	....	17.4	53 57.0 N	....	....	....	177.56	FB
Wuting	37 29.4 N	117 34	Aug 22, 15	14.7,16.8	3 44.0 W	11.0	54 00.1 N	15.4,16.3	.30475	9	177.1256	FB
Tehchow	37 26.9 N	116 26	Aug 26, 15	10.0,16.2,16.5	3 32.5 W	14.9	54 20.9 N	10.6,11.5	.30360	9	177.1256	FB
Yingpanshui	37 26.5 N	104 18	Mar 30, 16	14.0,16.4	0 29.6 W	10.8	54 55.1 N	14.6,15.9	.30324	9	177.1256	FB
			Mar 30, 16	....	....	17.4	54 56.4 N	....	....	....	177.26	FB
Chengchang	37 09.5 N	103 04	Jan 30, 16	13.7,15.7	0 01.8 E	11.7	54 31.5 N	14.2,15.2	.30598	9	177.1256	FB
			Jan 30, 16	....	....	16.7	54 30.2 N	....	....	....	177.26	FB
Erhshihlipu I	37 02.5 N	109 57	Dec 4, 15	10.2,11.6	2 01.8 W	12.8	54 09.2 N	10.6,11.3	.30772	12	206.12(56)	CKE
Nantsuitsa	37 01.2 N	110 17	Aug 3, 16	10.6,12.6	2 05.2 W	15.6	54 27.6 N	11.1,12.0	.30727	12	206.12(56)	CKE
Hokei	36 55.7 N	103 44	Mar 27, 16	13.8,16.6	0 18.8 W	11.0	54 13.3 N	14.8,16.1	.30718	9	177.125	FB
Yenmunkwan	36 47.7 N	109 49	Dec 6, 15	10.2,11.4	1 54.7 W	13.3	53 55.3 N	10.5,11.1	.30839	12	206.12(56)	CKE
Pingfan	36 44 N	103 26	Feb 2, 16	14.2,17.1	0 09.4 W	11.6	53 56.0 N	14.7,16.6	.30836	9	177.1256	FB
Tsinan	36 39.5 N	117 01	Aug 16, 15	9.8,11.8	3 36.2 W	15.3	53 05.9 N	10.4,11.3	.30831	9	177.1256	FB
Siningfu	36 37.3 N	101 56	Feb 10, 16	13.1,13.6,17.5	0 10.2 E	11.4	53 49.9 N	16.0 (3)	.30896	9	177.1256	FB
Yenanfu	36 33 N	109 21	Dec 8, 15	10.1,12.4	1 54.8 W	14.0	53 46.8 N	10.6,11.6	.30894	12	206.12(56)	CKE
Tungkwossu	36 31.0 N	101 16	Feb 13, 16	14.2,17.5	0 20.4 E	11.7	53 43.0 N	14.8,17.0	.30889	9	177.1256	FB
Kaomiaotzu	36 25.8 N	102 42	Feb 6, 16	13.4,15.4	0 01.2 E	10.1	53 35.1 N	14.0,15.0	.30994	9	177.1256	FB
Matszchi	36 14.8 N	109 20	Dec 10, 15	10.2,11.5	1 36.6 W	13.4	53 06.6 N	10.6,11.2	.31252	12	206.12(56)	CKE
Lungwangchan	36 10.1 N	110 20	Aug 5, 16	10.3,13.7	1 48.6 W	14.9	53 21.4 N	11.3,12.9	.31125	12	206.12(56)	CKE
Payenjungko	36 05.0 N	102 21	Feb 25, 16	13.3,15.5	0 03.8 E	11.6	53 04.4 N	13.8,15.0	.31246	9	177.1256	FB
Lanchowfu	36 03.4 N	103 48	Mar 17, 16	13.8,17.4	0 18.4 W	10.8	53 05.4 N	14.4,16.8	.31181	9	177.1256	FB
			Mar 23, 16	15.4,16.9	0 18.2 W	....	....	16.0	.31253	9	....	FB
Fohlokchuan	35 42.3 N	109 21	Dec 13, 15	9.9,11.3	1 32.0 W	13.5	52 23.7 N	10.2,10.9	.31496	12	206.12(56)	CKE
Hochow Kan	35 36.2 N	103 14	Mar 2, 16	13.0,17.0	0 08.0 W	11.0	52 27.7 N	13.7,15.6	.31602	9	177.1256	FB
Island (Hwang Ho)	35 25.4 N	110 25	Aug 8, 16	14.9,16.6	1 32.4 W	18.2	52 13.6 N	15.4,16.2	.31644	12	206.12(56)	CKE
Chengsokwan	35 13.4 N	108 57	Dec 15, 15	10.3 to 16.7 (dv)	1 34.5 W	....	....	....	....	12	....	INK
			Dec 16, 15	10.4,11.7	1 33.3 W	13.7	51 47.7 N	10.8,11.4	.31744	12	206.12(56)	CKE
Sanyüanhsien	34 36 N	108 58	Dec 18, 15	15.5,15.7	1 11.2 W	14.4	51 01.1 N	12.7,13.3	.32174	12	206.12(5)	CKE
Chingkuoping	34 29.0 N	110 00	Aug 14, 16	9.3,12.7	1 32.2 W	15.2	50 51.0 N	9.8,11.7	.32083	12	206.12(56)	CKE
			Aug 15, 16	6.0 to 18.2 (dv)	1 31.0 W	....	....	....	....	12	....	CKE
Kishan, *A*	34 19 N	107 29	Jan 1, 16	9.7	1 08.7 W	....	....	10.1,10.5	.32268	12	....	E&I
			Jan 1, 16	10.7 to 17.1 (dv)	1 10.6 W	....	....	....	....	12	....	E&I
Kishan, *B*	34 19 N	107 29	Jan 1, 16	....	....	14.0	50 41.8 N	....	....	....	206.12(56)	INK
Tungfufeng	34 17 N	108 14	Dec 30, 15	....	....	13.4	50 42.8 N	11.7,12.3	.32192	12	206.12(56)	CKE
Sianfu	34 16.3 N	108 57	Dec 22, 15	11.7,14.0	1 12.5 W	16.0	50 33.5 N	12.3,12.9	.32273	12	206.12(56)	E&I
Kwanyintong	34 03 N	106 49	Jan 4, 16	....	....	13.4	50 16.5 N	10.0,10.7	.32607	12	206.12(56)	E&I
Shangtsuan	34 03 N	110 09	Aug 21, 16	....	....	18.3	50 09.6 N	....	....	....	206.12(56)	CKE
			Aug 22, 16	6.0, 7.4	1 34.2 W	....	....	6.7	.32286	12	....	CKE
Fenghsien	33 53 N	106 33	Jan 7, 16	....	....	13.1	50 05.3 N	9.4,10.0	.32634	12	206.12(56)	E&I
Lungchüchai	33 41.0 N	110 15	Aug 24, 16	6.2,11.2	1 31.8 W	16.6	49 41.8 N	6.6,10.5	.32668	12	206.12(56)	CKE
Suchow An	33 39.1 N	116 58	Aug 11, 15	10.3	2 56.6 W	....	....	10.8	.32520	9	....	FB
			Aug 12, 15	13.2	2 57.9 W	10.7	49 00.7 N	13.7	.32563	9	177.1256	FB
Liupating	33 38 N	106 59	Jan 10, 16	10.3,11.7	0 53.8 W	14.8	49 23.7 N	10.7,11.3	.32780	12	206.12(56)	E&I
Erhshihlipu II	33 22 N	107 00	Jan 12, 16	15.5,16.2	1 02.5 W	....	....	15.8	.32913	12	....	E&I
Taianyi	33 08 N	106 08	Jan 20, 16	....	....	9.9	48 35.9 N	....	....	....	206.12(56)	INK
			Jan 21, 16	9.9,11.8	0 43.0 W	....	....	10.4,11.3	.33104	12	....	CKE
Hanchungfu	33 05.2 N	107 05	Jan 14, 16	15.1,17.3	0 11.1 W	....	....	15.6,16.9	.34356	12	....	CKE
			Jan 15, 16	8.0 to 17.4 (dv)	0 09.8 W	....	....	....	....	12	....	E&I
			Jan 17, 16	....	....	12.0	49 06.2 N	....	....	....	206.12(56)	INK
Laojentsang	32 58.9 N	111 18	Aug 30, 16	7.9,10.7	1 42.4 W	13.0	48 27.2 N	9.1,10.1	.33077	12	206.12(5)	CKE
			Aug 30, 16	....	....	14.2	48 28.4 N	....	....	....	206.(5)	CKE
Shanchatsz, *A*	32 45 N	103 52	Feb 14, 16	....	....	....	....	14.3	.33156	12	....	CKE
Shanchatsz, *B*	32 45 N	103 52	Feb 14, 16	....	....	14.4	48 21.8 N	....	....	....	206.12	INK
Pikow	32 44.7 N	105 18	Jan 31, 16	....	....	16.5	48 15.6 N	....	....	....	206.12(56)	INK
			Feb 1, 16	9.2	0 25.9 W	....	....	9.8,12.9	.33206	12	....	CKE
			Feb 1, 16	10.3 to 12.0 (dv)	0 25.4 W	....	....	....	....	12	....	INK
			Feb 1, 16	13.5 to 17.7 (dv)	0 26.5 W	....	....	....	....	12	....	INK
Paishuiho	32 40 N	105 32	Jan 29, 16	9.9,11.7	0 28.0 W	16.2	48 15.5 N	10.4,11.4	.33208	12	206.12(56)	E&I
Tumuntsz	32 39.3 N	106 00	Jan 24, 16	13.4,15.0	0 32.6 W	16.7	48 35.1 N	13.8,14.6	.33161	12	206.12(56)	E&I
Sungpan	32 39.2 N	103 46	Feb 16, 16	15.6,17.4	0 12.8 W	12.9	48 09.6 N	16.0,17.0	.33302	12	206.12(56)	E&I

ASIA.

CHINA—*Continued.*

Station	Latitude	Long. East of Gr.	Date	Declination: Local Mean Time	Declination: Value	Inclination: L. M. T.	Inclination: Value	Hor. Intensity: L. M. T.	Hor. Intensity: Value	Instruments: Mag'r	Instruments: Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Lautangfong	32 34 N	103 56	Feb 12, '16	9.2,11.2	0 26.6 W	14.2	48 18.7 N	9.7,10.8	.33274	12	206.12(56)	E&I
Shuichingchan	32 29.2 N	104 22	Feb 8, 16	....	....	16.7	47 55.0 N	....	....	......	206.12	INK
			Feb 9, 16	8.2,11.6	0 20.6 W	13.2	47 56.4 N	8.7,11.2	.33400	12	206.(56)	E&I
Kwangyüan	32 26 N	105 51	Jan 26, 16	10.7,12.3	0 46.1 W	16.5	47 45.6 N	11.0,11.9	.33504	12	206.12(56)	E&I
Chingchun	32 24 N	105 00	Feb 4, 16	....	....	11.0	47 45.3 N	9.0, 9.8	.33488	12	206.12(56)	CKE
Laohokow	32 23.2 N	111 38	Sep 1, 16	16.6,17.6	1 50.6 W	....	....	17.1	.33294	12	....	CKE
			Sep 2, 16	6.6 to 17.1 (dv)	1 44.8 W	....	....	....	....	12	....	CKE
			Sep 4, 16	8.9	1 41.9 W	10.1	47 38.7 N	8.5	.33260	12	206.12(56)	CKE
Lunganfu	32 22 N	104 36	Feb 5, 16	....	....	16.4	47 47.0 N	....	....	......	206.12(56)	INK
			Feb 7, 16	....	....	....	....	10.1,11.0	.33470	12	....	CKE
Shawan	32 04.5 N	103 40	Feb 19, 16	....	....	17.0	47 21.3 N	....	....	......	206.12(56)	INK
			Feb 20, 16	8.8,11.2	0 21.4 W	....	....	9.3,10.7	.33624	12	....	CKE
Ichenghsien	31 44.0 N	112 15	Sep 5, 16	....	....	18.0	46 48.7 N	....	....	......	206.12	CKE
			Sep 6, 16	8.7,10.4	1 44.9 W	11.2	46 41.0 N	9.2,10.1	.33582	12	206.(56)	CKE
Tsunchü	31 38.5 N	103 44	Feb 23, 16	9.8,12.7	0 13.2 W	16.5	46 44.7 N	10.3,11.7	.33743	12	206.12(56)	E&I
Weichow	31 27 N	103 29	Feb 25, 16	....	....	16.0	46 23.5 N	12.0,14.6	.33887	12	206.12(56)	E&I
Lukiapang, D_a	31 19.0 N	121 02	Nov 2, 17	13.5,15.3,15.6	3 20.4 W	....	....	14.0,14.8	.33229	9	....	FB
			Nov 2, 17	....	....	....	....	16.1,16.9	.33236	9	....	FB
			Nov 3, 17	8.3, 8.5, 9.1	3 15.2 W	....	....	9.7,10.6	.33246	9	....	FB
			Nov 3, 17	11.1,13.2,13.5	3 18.9 W	....	....	11.7	.33270	9	....	FB
Lukiapang, D_b	31 19.0 N	121 02	Oct 31, 17	....	....	8.8,10.9	45 31.6 N	....	....	......	206.12(5)	FB
			Oct 31, 17	....	....	16.6	45 32.2 N	....	....	......	206.12(56)	FB
			Nov 1, 17	....	....	16.2	45 33.3 N	....	....	......	206.12(56)	FB
Lukiapang, *F*	31 19.0 N	121 02	Oct 31, 17	13.5,15.3	3 18.4 W	....	....	14.0,14.9	.33206	9	....	FB
			Nov 1, 17	9.0,14.3	3 16.4 W	....	....	9.5,13.9	.33228	9	....	FB
			Nov 1, 17	14.8,15.0	3 18.8 W	....	....	....	....	9	....	FB
			Nov 2, 17	9.3 to 11.7 (4)	3 16.2 W	....	....	9.7,10.6	.33224	9	....	FB
Anlu	31 10.7 N	112 35	Sep 7, 16	9.3,11.5	1 38.3 W	14.2	45 55.6 N	9.8,11.0	.33860	12	206.12(56)	CKE
Patung	31 02.3 N	110 25	Apr 24, 16	8.5, 8.8,10.2	1 29.6 W	11.5	45 47.2 N	9.2, 9.8	.34014	12	206.12(56)	E&I
Kweichowfu	31 01 N	109 34	Apr 22, 16	....	....	13.8	45 46.2 N	11.3,12.2	.34146	12	206.12(56)	E&I
Kwanhsien	30 58.4 N	103 33	Feb 29, 16	10.7,14.5	0 09.4 W	16.4	45 50.3 N	11.3,13.0	.34162	12	206.12(56)	E&I
Wanhsien	30 48 N	108 25	Apr 18, 16	13.2,14.6	1 07.7 W	16.7	45 24.4 N	13.6,14.3	.34257	12	206.12(56)	E&I
			Apr 18, 16	....	....	18.1	45 26.6 N	....	....	......	206.(56)	INK
Ichang, *A*	30 43.3 N	111 18	Apr 26, 16	9.7,11.3	1 35.8 W	15.5	45 21.1 N	10.2,10.8	.34062	12	206.12(56)	E&I
			Nov 13, 16	13.3,16.6	1 32.7 W	10.5	45 14.6 N	13.9,16.1	.34098	9	206.12	FB
Ichang, *B*	30 42.9 N	111 18	Nov 14, 16	....	....	16.0	45 16.8 N	....	....	......	206.12	FB
			Nov 15, 16	5.7 to 18.3 (dv)	1 32.1 W	....	....	....	....	9	....	FB
			Nov 16, 16	8.7,10.8	1 31.0 W	....	....	9.3,10.4	.34112	9	....	FB
Chengtu	30 38.0 N	104 03	Mar 6, 16	10.6,12.5	0 08.0 W	15.0	45 09.9 N	11.1,12.1	.34368	12	206.12	E&I
			Mar 7, 16	....	....	15.6	45 12.1 N	....	....	......	206.12	INK
Hankow	30 36.4 N	114 20	May 9, 16	10.2,11.8	1 53.7 W	16.3	44 50.6 N	10.5,11.3	.34086	12	206.12(56)	E&I
			Oct 30, 16	9.3,11.8	1 53.6 W	16.2	44 49.8 N	9.9,11.2	.34098	9	206.12(56)	FB
Kiungchow	30 24.1 N	103 25	Mar 15, 16	10.5 to 18.0 (dv)	0 07.8 W	....	....	....	....	12	....	INK
			Mar 16, 16	7.3,10.6	0 06.6 W	11.9	44 47.4 N	7.7,10.1	.34464	12	206.12(56)	E&I
Tatzekow, *A*	30 23 N	112 51	Sep 8, 16	18.2	1 36.0 W	....	....	....	....	12	....	CKE
Tatzekow, *B*	30 23 N	112 51	Sep 8, 16	....	....	17.7	44 49.9 N	....	....	......	206.12	CKE
Hangchow	30 18 N	120 08	Oct 29, 17	9.4,11.2	2 52.4 W	16.2	44 04.8 N	9.9,10.8	.33719	9	206.12(56)	FB
Chungchow	30 17.1 N	108 03	Apr 17, 16	9.9,11.4	0 58.2 W	12.7	44 41.8 N	10.3,11.0	.34494	12	206.12(56)	E&I
Shasi	30 16 N	112 17	May 1, 16	....	....	14.8	44 32.8 N	16.4,17.1	.34317	12	206.12(56)	E&I
Yachowfu	29 58.8 N	102 56	Mar 18, 16	....	....	11.4	44 14.2 N	15.4,16.5	.34704	12	206.12(56)	E&I
			Mar 19, 16	10.1,10.4	0 01.8 W	....	....	....	....	12	....	INK
			Mar 19, 16	15.2,15.4	0 04.9 W	....	....	....	....	12	....	INK
Ningpo	29 53.5 N	121 33	Nov 7, 17	9.4,11.2	3 02.6 W	7.5	43 23.7 N	9.9,10.8	.33810	9	206.12(56)	FB
Tunglu	29 46 N	119 39	Oct 26, 17	9.8,11.4	2 36.4 W	13.7,14.8	43 23.7 N	10.2,11.1	.33972	9	206.12(56)	FB
Fowchow	29 41.8 N	107 24	Apr 15, 16	7.6, 8.2,10.0	0 40.7 W	17.8	43 34.6 N	10.8,15.9	.35002	12	206.12(5)	E&I
			Apr 15, 16	11.3 to 15.3 (dv)	0 46.2 W	....	....	....	....	12	....	INK
			Apr 15, 16	16.4	0 45.4 W	....	....	....	....	12	....	INK
Tsingshih	29 38.3 N	111 48	May 10, 15	14.0,16.1,16.4	1 18.4 W	....	....	14.6,15.6	.34744	9	....	FB
			May 11, 15	9.8	1 17.1 W	11.2	43 23.6 N	10.2	.34705	9	177.12	FB
Shihmen Hun	29 34.7 N	111 16	May 13, 15	9.9,16.0	1 12.6 W	14.7	43 17.3 N	10.4,11.3	.34792	9	177.1256	FB
			May 13, 15	....	....	....	....	16.4	.34809	9	....	FB
Kiatingfu	29 33.3 N	103 41	Mar 27, 16	9.6,11.6	0 17.1 W	15.4	43 23.6 N	10.4,11.2	.35142	12	206.12(56)	E&I
Chungking	29 33 N	106 33	Apr 10, 16	16.5,18.1	0 42.0 W	11.3	43 18.1 N	16.9,17.7	.35005	12	206.12(56)	E&I
			Apr 11, 16	....	....	16.4	43 19.6 N	....	....	......	206.12(56)	INK
Omeishan*	29 31.8 N	103 16	Mar 24, 16	10.2	2 45.6 W	15.9	45 43.2 N	10.8,11.8	.35458	12	206.12(56)	E&I
			Mar 25, 16	9.4, 9.8	2 50.4 W	....	....	....	....	12	....	INK
Junghsien	29 27.7 N	104 22	Mar 30, 16	8.8,10.8	0 24.4 W	12.1	43 11.7 N	9.3,10.4	.35026	12	206.12(5)	E&I
Yochow	29 27.1 N	113 12	May 4, 16	15.5	1 36.7 W	13.5	43 04.8 N	16.1	.34763	12	206.12(56)	E&I
			May 5, 16	8.1	1 30.0 W	....	....	7.5	.34746	12	....	E&I
			Nov 1, 16	....	....	15.4	43 09.3 N	....	....	......	206.12(5)	FB
			Nov 2, 16	5.9 to 18.4 (dv)	1 34.1 W	....	....	....	....	9	....	FB
			Nov 3, 16	14.6,16.8	1 33.4 W	....	....	15.2,16.4	.34770	9	....	FB

* Local disturbance.

ASIA.

CHINA—*Continued.*

Station	Latitude	Long. East of Gr.	Date	Declination		Inclination		Hor. Intensity		Instruments		Obs'r
				Local Mean Time	Value	L. M. T.	Value	L. M. T.	Value	Mag'r	Dip Circle	
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Tzeli	29 26.4 N	111 01	May 15, '15	14.8	1 12.2 W	10.8	43 03.7 N	15.4	.34890	9	177.1256	FB
Tungchingwan	29 24 N	105 45	Apr 6, 16	15.6,16.4	0 28.8 W	17.6	43 08.8 N	16.0	.35164	12	206.12(56)	E&I
Tzeliutsing	29 22 N	104 42	Mar 31, 16	....	....	17.1	43 04.8 N	....	....	....	206.12(56)	INK
			Apr 1, 16	....	....	....	....	13.6,15.0	.35084	12	....	CKE
Chushangpu	29 17.7 N	119 29	Oct 24, 17	12.4,14.0	2 24.6 W	10.9	42 33.1 N	12.8,13.7	.34347	9	206.12(56)	FB
			Oct 24, 17	....	....	14.8	42 32.8 N	....	....	....	206.12	FB
Kiangtsing	29 11 N	106 10	Nov 27, 16	....	....	9.6	42 56.6 N	10.7	.35153	9	206.12	FB
Yungting	29 07 N	110 22	May 18, 15	....	....	11.2	42 34.4 N	13.8,14.7	.35036	9	177.1256	FB
Changteh	29 01.9 N	111 33	May 5, 15	10.0,14.7	1 13.4 W	16.9	42 25.2 N	10.5,11.4	.35053	9	177.1256	FB
			May 7, 15	14.4,14.7	1 14.4 W	....	....	....	....	9	....	FB
Yungshunfu	29 00.8 N	109 53	May 22, 15	12.8,15.1,15.9	0 58.4 W	10.9	42 24.1 N	13.4,14.7	.35136	9	177.1256	B&I
Jaochow	29 00.1 N	116 38	Oct 10, 17	9.8,11.4	2 01.9 W	14.7	42 16.7 N	10.2,11.0	.34680	9	206.12(56)	FB
Sungki	28 58 N	105 51	Nov 28, 16	....	....	12.0	42 29.0 N	....	....	....	206.12(56)	FB
Chüchowfu	28 57.2 N	118 51	Oct 22, 17	9.9,11.5	2 17.1 W	14.5	42 09.9 N	10.3,11.1	.34479	9	206.12(56)	FB
Changshan Che	28 53.4 N	118 28	Oct 19, 17	13.0,14.6	2 14.0 W	11.0	42 03.0 N	13.4,14.3	.34525	9	206.12(56)	FB
Luchow	28 53.2 N	105 29	Nov 30, 16	15.1,17.2	0 27.3 W	9.8	42 18.0 N	15.7,16.7	.35314	9	206.12(56)	FB
			Nov 30, 16	....	....	10.8	42 17.1 N	....	....	....	206.(56)	FB
Suifu	28 46.0 N	104 38	Dec 4, 16	6.0 to 18.4 (dv)	0 25.5 W	....	....	....	....	9	....	FB
			Dec 5, 16	....	....	7.8	41 58.8 N	....	....	....	206.12(56)	FB
			Dec 6, 16	11.1,14.7	0 23.7 W	....	....	11.7,14.3	.35455	9	....	FB
Paotsing	28 43.1 N	109 49	May 25, 15	9.6,11.7,12.1	0 52.5 W	13.6	41 55.9 N	10.3,11.2	.35262	9	177.1256	B&I
Nanchang, *A*	28 42.4 N	115 51	Oct 5, 17	....	....	15.9	41 49.1 N	....	....	....	206.12(56)	FB
			Oct 6, 17	6.8,11.0	1 50.8 W	....	....	7.3,10.6	.34865	9	....	FB
Nanchang, *B*	28 42.2 N	115 51	Oct 6, 17	14.0,16.0	1 52.3 W	17.2	41 52.1 N	14.5,15.6	.34847	9	206.12(56)	FB
Shenchowfu	28 27.7 N	110 15	Apr 30, 15	9.5,11.6	0 57.2 W	14.6	41 31.6 N	10.0,11.0	.35322	9	177.1256	FB
			May 1, 15	15.1,15.6	0 57.6 W	....	....	....	....	9	....	FB
Kwangsinfu	28 26.3 N	117 56	Oct 15, 17	5.9 to 18.2 (dv)	2 00.3 W	....	....	....	....	9	....	FB
			Oct 16, 17	9.7,11.4	1 59.0 W	7.1	41 22.8 N	10.1,11.1	.34716	9	206.12(56)	FB
Iyang Ki	28 25.6 N	117 24	Oct 13, 17	12.6,15.0	1 56.2 W	11.2	41 29.1 N	13.0,14.5	.34783	9	206.12(56)	FB
Tantow Yun	28 20 N	104 15	Dec 11, 16	....	....	15.5	41 16.2 N	....	....	....	206.12(56)	FB
			Dec 12, 16	....	....	....	....	8.1, 9.1	.35641	9	....	FB
Puerhtu	28 15 N	104 10	Dec 12, 16	....	....	16.3	41 11.7 N	....	....	....	206.12(56)	FB
Sungtao	28 10.6 N	109 14	May 29, 15	9.8,11.6,15.6	0 46.3 W	13.9	41 01.0 N	10.4,11.2	.35540	9	177.1256	B&I
Towshakwan	28 02 N	104 04	Dec 14, 16	....	....	17.4	40 53.9 N	16.1	.35562	9	206.1	FB
Fuchow Ki	28 01.0 N	116 18	Oct 1, 17	5.8 to 18.4 (dv)	1 47.5 W	....	....	....	....	9	....	FB
			Oct 2, 17	9.5,11.4,15.9	1 47.4 W	14.1	40 41.5 N	9.9,11.0	.35122	9	206.12(56)	FB
			Oct 2, 17	....	....	....	....	16.3	.35126	9	....	FB
Wenchow	28 00.9 N	120 38	Nov 10, 17	15.4,17.1	2 14.8 W	12.4	40 55.5 N	15.9,16.7	.34346	9	206.12(56)	FB
Chenki	27 58.9 N	110 07	Apr 28, 15	13.4,15.3	0 52.8 W	17.0	40 44.9 N	13.9,14.8	.35598	9	177.1256	FB
Szenan	27 56.4 N	108 18	Jun 3, 15	....	....	11.2	40 39.2 N	....	....	....	177.1256	FB
			Jun 4, 15	14.0,16.3	0 37.8 W	....	....	14.5,15.7	.35708	9	....	FB
Meitan	27 46.3 N	107 33	Jun 9, 15	9.8,14.8,15.1	0 31.7 W	16.6	40 22.1 N	11.3,13.9	.35804	9	177.1256	B&I
Takwan	27 45 N	103 50	Dec 18, 16	....	....	14.4	40 21.4 N	9.3,10.5	.35869	9	206.12(56)	FB
			Dec 18, 16	....	....	15.6	40 23.1 N	....	....	....	206.(56)	FB
Tsunyi	27 41.7 N	106 59	Jun 12, 15	13.9,15.8	0 28.6 W	11.2	40 09.1 N	14.5,15.3	.35866	9	177.1256	B&I
Kienchangfu	27 33.1 N	116 36	Sep 28, 17	13.7,15.5	1 39.2 W	17.1	39 58.9 N	14.1,15.1	.35292	9	206.12(56)	FB
Linki	27 29.8 N	120 23	Nov 14, 17	9.5,11.1	1 19.8 W	13.8,16.0	41 07.9 N	9.9,10.8	.34549	9	206.12(56)	FB
Yüanchow Hun	27 26.9 N	109 37	Apr 24, 15	13.7,16.2	0 45.2 W	11.2	39 47.4 N	14.2,16.7	.35860	9	177.1256	FB
Shaowu	27 21.2 N	117 28	Sep 24, 17	9.9,11.5	1 46.4 W	16.8	39 30.4 N	10.4,11.2	.35306	9	206.12(56)	FB
Chaotung Yun	27 21.1 N	103 45	Dec 21, 16	9.9,12.5	0 02.8 E	16.9	40 13.6 N	10.5,11.4	.35752	9	206.12(56)	FB
Paoking	27 15.0 N	111 23	Apr 10, 15	15.2,17.0	0 55.2 W	....	....	15.8,16.6	.35808	9	....	FB
			Apr 11, 15	12.8	0 57.0 W	11.1	39 25.2 N	13.3	.35872	9	177.1256	FB
Pailin	27 11.8 N	120 10	Nov 16, 17	....	....	17.4	39 14.9 N	....	....	....	206.12(6)	FB
			Nov 17, 17	7.1	2 43.7 W	....	....	6.7	.35169	9	....	FB
Sihfeng	27 06.5 N	106 45	Jun 16, 15	13.6,15.9	0 23.3 W	10.8	39 09.6 N	14.3,15.3	.36128	9	177.1256	B&I
Shuikowchai	26 59.4 N	117 50	Sep 21, 17	12.9,14.6	1 44.6 W	11.1	38 59.9 N	13.3,14.2	.35348	9	206.12(56)	FB
Hengchowfu	26 55.0 N	112 33	Apr 5, 15	9.6,11.4	0 58.0 W	15.1	38 53.8 N	10.1,11.0	.35884	9	177.1256	FB
Funingfu	26 53.0 N	120 00	Nov 19, 17	9.5,11.2,11.4	1 57.3 W	14.8	38 49.7 N	9.9,10.8	.35108	9	206.12(56)	FB
Yichesun	26 49.6 N	103 31	Dec 26, 16	9.4,11.5	0 00.2 W	15.2	39 09.3 N	10.0,11.0	.35894	9	206.12(56)	FB
Wukangchow, *A*	26 43.6 N	110 38	Apr 16, 15	12.9,15.6	0 45.4 W	17.6	38 36.6 N	14.3(3)	.36129	9	177.12	FB
Wukangchow, *B*	26 43.6 N	110 38	Apr 15, 15	....	....	16.5	38 36.5 N	....	....	....	177.125	FB
Yenpingfu	26 39.1 N	118 08	Sep 15, 17	13.8,15.6,16.3	1 40.8 W	17.7	38 19.6 N	14.3,15.2	.35510	9	206.12(56)	FB
			Sep 17, 17	5.8 to 18.2 (dv)	1 38.5 W	....	....	....	....	9	....	FB
Santuao	26 37.7 N	119 40	Nov 21, 17	14.8,16.3	1 56.1 W	11.0	38 30.8 N	15.1,16.0	.35232	9	206.12(56)	FB
Kweiyang	26 34.0 N	106 42	Jun 21, 15	13.6,16.6	0 21.4 W	11.1	38 20.4 N	14.4,15.3	.36300	9	177.1256	FB
Loyüanhsien	26 30.9 N	119 29	Nov 22, 17	16.8	1 33.0 W	17.4	37 57.8 N	16.4	.35350	9	206.12	FB
Tungchwan Yun	26 25.4 N	103 17	Dec 29, 16	8.5,11.6,15.4	0 12.7 W	16.2	37 38.9 N	9.1,11.2	.36981	9	206.12(5)	FB
Leiyang	26 24.6 N	112 42	Apr 2, 15	14.9,15.2,17.2	0 59.7 W	10.9	38 02.8 N	15.7,16.7	.36051	9	177.1256	FB
Shuikow Fu	26 21.7 N	118 45	Nov 30, 17	9.8,11.5	1 41.3 W	16.0	37 47.7 N	10.3,11.2	.35552	9	206.12(56)	FB
Tuyünfu	26 15.5 N	107 26	Jun 27, 15	14.1,16.1	0 24.0 W	11.0	37 44.9 N	14.7,15.6	.36412	9	177.1256	FB

ASIA.

CHINA—*Continued.*

Station	Latitude	Long. East of Gr.	Date	Declination: Local Mean Time	Declination: Value	Inclination: L. M. T.	Inclination: Value	Hor. Intensity: L. M. T.	Hor. Intensity: Value	Instruments: Mag'r	Instruments: Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Yunghinghsien	26 09 N	112 58	Apr 1, '15	9.5,11.7	0 58.9 W	14.9	37 32.0 N	10.0,11.2	.36138	9	177.1256	FB
Foochow	26 02.1 N	119 19	Nov 26, 17	9.3,11.6	1 42.4 W	14.8	37 29.0 N	9.8,11.2	.35504	9	206.12(56)	FB
			Nov 26, 17	....	....	....	....	12.3	.35492	9	....	FB
			Nov 28, 17	9.2,11.0	1 42.8 W	13.9	37 27.6 N	9.8,10.7	.35516	9	206.12(56)	FB
Laitowpo	26 00.6 N	103 24	Dec 31, 16	....	....	17.2	37 05.1 N	....	....	....	206.12(6)	FB
			Jan 1, 17	5.8 to 18.2 (dv)	0 16.4 E	....	....	....	....	9	....	FB
			Jan 2, 17	7.3, 9.2	0 17.8 W	....	....	7.8, 8.7	.36330	9	....	FB
Yungan Fu	25 59.3 N	117 20	Sep 12, 17	14.0,16.5	1 22.0 W	11.2	37 12.3 N	14.5,16.1	.35832	9	206.12(56)	FB
Chenchow	25 48.0 N	112 59	Mar 30, 15	10.0,16.0,16.5	0 51.4 W	14.6	36 58.5 N	10.5,11.5	.36174	9	177.1256	FB
Siaotao	25 44.7 N	117 06	Sep 10, 17	9.5,11.3	1 24.3 W	14.7	36 50.3 N	10.0,10.9	.35944	9	206.12(56)	FB
Talifu, *B*	25 42.7 N	100 11	Jan 31, 17	....	....	11.5	36 34.2 N	....	....	....	206.12(56)	FB
			Feb 1, 17	6.3 to 18.6 (dv)	0 02.0 E	....	....	....	....	9	....	FB
			Feb 2, 17	9.8,11.7	0 02.5 E	....	....	10.3,11.3	.36784	9	....	FB
Talifu, *A*	25 41.7 N	100 10	Jan 30, 17	10.0,11.8	0 06.2 W	14.7	36 37.9 N	10.5,11.4	.36708	9	206.12(56)	FB
Liushuho	25 38.7 N	103 15	Jan 3, 17	14.2	0 04.0 W	16.9	36 36.1 N	14.7	.36590	9	206.12(56)	FB
Taipingpu	25 35.5 N	99 52	Feb 6, 17	....	....	17.3	36 31.6 N	....	....	....	206.12(56)	FB
			Feb 7, 17	7.5	0 04.4 E	....	....	8.0	.36797	9	....	FB
Siukiu	25 26.4 N	117 10	Sep 7, 17	....	....	17.5	36 22.7 N	....	....	....	206.12(56)	FB
			Sep 8, 17	6.5, 7.5	1 18.6 W	....	....	6.9	.36004	9	....	FB
Yangkai	25 25.6 N	103 07	Jan 4, 17	15.6,16.8	0 06.0 W	17.6	36 33.2 N	16.2	.36596	9	206.12	FB
Lipohsien	25 25.1 N	107 47	Jul 2, 15	10.2,11.9	0 21.9 W	14.1	36 16.8 N	10.7,11.5	.36745	9	177.1256	FB
			Jul 2, 15	....	....	17.0	36 17.8 N	....	....	....	177.2	B&I
Yunnanyi	25 25.0 N	100 41	Jan 24, 17	17.6	0 02.4 E	....	....	17.1	.36736	9	....	FB
			Jan 25, 17	....	....	7.8	36 22.8 N	....	....	....	206.12(56)	FB
Shanyang Yun	25 18.7 N	99 24	Feb 9, 17	....	....	17.6	36 00.1 N	....	....	....	206.12(5)	FB
			Feb 10, 17	7.7, 8.9	0 03.2 E	....	....	8.2	.36962	9	....	FB
Shakiao	25 15.1 N	101 09	Jan 22, 17	15.2,17.1	0 02.6 E	10.7	35 53.7 N	15.7,16.7	.36933	9	206.12(56)	FB
Kwangtunghsien	25 10.9 N	101 48	Jan 19, 17	13.1,15.5	0 05.8 W	....	....	14.3,15.2	.36990	9	....	FB
			Jan 20, 17	....	....	7.9	35 52.4 N	....	....	....	206.12(56)	FB
Lufenghsien	25 09.9 N	102 06	Jan 16, 17	6.4 to 18.7 (dv)	0 06.3 W	....	....	....	....	9	....	FB
			Jan 17, 17	9.8,11.7	0 08.6 W	16.3	36 00.2 N	10.3,11.3	.36898	9	206.12(56)	FB
Yungchang	25 07.8 N	99 11	Feb 12, 17	9.5,11.4,11.6	0 05.7 E	15.9	35 35.7 N	10.0,10.9	.37027	9	206.12(56)	FB
Lungyenchow	25 06.9 N	117 02	Sep 5, 17	9.7,11.4	1 21.9 W	14.8	35 42.1 N	10.2,11.1	.36149	9	206.12(56)	FB
Yünnanfu, *A*	25 04.2 N	102 42	Jan 10, 17	9.6,11.5	0 02.8 W	16.2	35 19.3 N	10.1,11.1	.37192	9	206.12(56)	FB
Yünnanfu, *B*	25 04.2 N	102 42	Jan 11, 17	12.5,14.4	0 04.4 W	16.5	35 20.2 N	13.0,14.0	.37204	9	206.12(56)	FB
Tengyueh	25 01.8 N	98 30	Feb 20, 17	14.3,16.2	0 35.8 W	11.6	35 05.4 N	14.8,15.8	.37212	9	206.12(56)	FB
Ta Tit Tsuen	24 59.9 N	108 06	Jul 5, 15	....	....	18.0	35 31.0 N	....	....	....	177.1256	FB
			Jul 6, 15	9.4,13.0,15.8	0 20.3 W	8.3	35 29.2 N	10.9,12.2	.36936	9	177.16	B&I
Homushu	24 59.7 N	98 50	Feb 15, 17	5.9 to 18.0 (dv)	0 00.8 E	....	....	....	....	9	....	FB
			Feb 16, 17	9.3,11.4	0 00.2 E	14.6	35 21.8 N	9.8,11.0	.37010	9	206.12(56)	FB
Chüanchowfu	24 54.6 N	118 37	Dec 6, 17	9.6,11.3	1 12.1 W	6.9	35 19.9 N	10.1,11.0	.36178	9	206.12(6)	FB
Shiuchow	24 47.6 N	113 22	Mar 24, 15	15.0,17.4	0 46.7 W	12.5	35 10.5 N	15.5,16.4	.36542	9	177.1256	FB
Yungting	24 43.1 N	116 44	Sep 1, 17	....	....	17.9	35 09.3 N	....	....	....	206.12(56)	FB
			Sep 2, 17	7.3, 9.3	1 08.2 W	....	....	7.8, 8.8	.36304	9	....	FB
Siaosinkai	24 40 N	97 55	Feb 24, 17	16.7	0 05.1 E	....	....	17.2,18.1	.37244	9	....	FB
			Feb 25, 17	....	....	8.5	34 38.9 N	....	....	....	206.12(5)	FB
Kingyüan	24 30.4 N	108 33	Jul 10, 15	10.2,16.8	0 18.9 W	14.4	34 34.1 N	10.7,11.6	.37074	9	177.1256	FB
			Jul 10, 15	....	....	15.7	34 34.2 N	....	....	....	177.56	INK
Tsungkow	24 29.8 N	116 25	Aug 28, 17	14.4,16.1	1 00.8 W	17.7	34 30.8 N	14.8,15.7	.36573	9	206.12(56)	FB
Amoy	24 26.2 N	118 04	Dec 3, 17	14.8,16.5	1 04.8 W	11.1	34 52.0 N	15.3,16.1	.36139	9	206.12(56)	FB
Samhopa	24 24.7 N	116 34	Aug 29, 17	14.9,15.9	1 11.1 W	17.5	34 36.6 N	15.4	.36398	9	206.12(56)	FB
			Aug 30, 17	5.9 to 18.1 (dv)	1 10.8 W	....	....	....	....	9	....	FB
Pingka	24 21.4 N	98 56	Mar 23, 17	10.1,12.8	0 02.8 E	15.2	34 04.9 N	10.6,11.4	.37369	9	206.12(56)	FB
Kaying	24 21.1 N	116 08	Aug 27, 17	9.5,11.4	1 03.8 W	14.8	34 24.4 N	10.0,11.0	.36504	9	206.12(56)	FB
Liuchowfu	24 19.8 N	109 19	Jul 12, 15	13.0,15.2	0 23.2 W	16.2	34 19.0 N	13.6,14.7	.37062	9	177.1256	B&I
			Jul 13, 15	10.0,10.6,14.9	0 22.2 W	....	....	....	....	9	....	B&I
			Jul 13, 15	15.1 to 17.1 (dv)	0 22.5 W	....	....	....	....	9	....	B&I
Mengka	24 15.6 N	98 28	Mar 19, 17	17.2,18.2	0 01.6 E	....	....	17.6	.37378	9	....	FB
			Mar 20, 17	....	....	7.3	33 57.8 N	....	....	....	206.12(56)	FB
Hankuai Ferry	24 15.2 N	99 04	Mar 25, 17	10.8	0 04.2 E	10.1	33 50.1 N	11.3	.37479	9	206.12	FB
Laolung	24 07.0 N	115 16	Aug 23, 17	16.1,17.9	0 48.6 W	11.2	33 53.6 N	16.7,17.6	.36608	9	206.12(56)	FB
Kwangnanfu	24 02.4 N	104 59	May 22, 17	....	....	17.7	33 36.9 N	....	....	....	206.12(56)	FB
			May 23, 17	8.9,11.4,14.6	0 10.7 W	....	....	9.5,11.0	.37428	9	....	FB
			May 23, 17	....	....	....	....	15.3	.37438	9	....	FB
Mengmow	24 01.5 N	97 51	Mar 16, 17	9.3,11.4,11.7	0 00.4 W	15.4	33 22.5 N	9.8,10.9	.37578	9	206.12(56)	FB
Siang	23 57.8 N	109 37	Jul 16, 15	14.4,16.7	0 19.2 W	11.4	33 36.4 N	15.1,16.3	.37276	9	177.12	FB
			Jul 17, 15	11.5	0 19.1 W	9.3	33 38.5 N	10.8	.37233	9	177.1256	FB
Poseh	23 55.0 N	106 32	Jun 2, 17	16.0,17.8	0 15.8 W	11.3	33 18.8 N	16.5,17.4	.37394	9	206.12(56)	FB
			Jun 3, 17	7.0 to 18.2 (dv)	0 14.5 W	....	....	....	....	9	....	FB
Mengtui	23 53.0 N	98 53	Mar 27, 17	....	....	17.8	33 13.8 N	....	....	....	206.12(56)	FB
			Mar 28, 17	6.9, 7.6	0 01.6 E	....	....	8.1	.37527	9	....	FB
Achikai	23 49.1 N	104 27	May 19, 17	....	....	18.1	33 14.2 N	....	....	....	206.12(56)	FB
			May 20, 17	6.2, 7.9	0 08.2 W	....	....	6.7, 7.5	.37560	9	....	FB

ASIA.

CHINA—*Continued.*

Station	Latitude	Long. East of Gr.	Date	Declination		Inclination		Hor. Intensity		Instruments		Obs'r
				Local Mean Time	Value	L. M. T.	Value	L. M. T.	Value	Mag'r	Dip Circle	
	° ′	° ′		*h h h*	° ′	*h h*	° ′	*h h*	*c. g. s.*			
Lokung	23 48 N	105 22	May 26, '17	15.4,17.1	0 11.0 W	18.1	33 06.5 N	15.8,16.7	.37510	9	206.12(56)	FB
Lutungpu	23 38.8 N	102 06	Apr 30, 17	....	....	18.0	32 54.0 N	....	....	....	206.12(56)	FB
			May 1, 17	5.8 to 8.1 (dv)	0 06.6 W	....	....	....	....	9	....	FB
			May 2, 17	6.8, 8.5	0 02.3 W	....	....	7.3, 8.2	.37560	9	....	FB
Szefangching	23 38.7 N	99 10	Apr 1, 17	5.7 to 18.3 (dv)	0 06.3 E	....	....	....	....	9	....	FB
			Apr 2, 17	9.4,11.4	0 08.0 E	15.0	32 50.2 N	9.9,10.9	.37724	9	206.12(56)	FB
			Apr 2, 17	....	....	15.9	32 47.6 N	....	....	....	206.(56)	FB
Linanfu	23 38.2 N	102 51	May 5, 17	....	....	17.7	32 44.5 N	....	....	....	206.12(56)	FB
			May 6, 17	7.2, 9.0	0 03.1 W	....	....	7.6, 8.5	.37602	9	....	FB
Kweitsao	23 38.1 N	105 47	May 29, 17	....	....	18.6	32 55.0 N	....	....	....	206.12(56)	FB
			May 30, 17	7.2, 8.8	0 08.6 W	....	....	7.7, 8.5	.37504	9	....	FB
Pingma	23 36.9 N	107 04	Jun 7, 17	9.1,10.9	0 12.6 W	15.7	32 47.1 N	9.6,10.5	.37568	9	206.12(56)	FB
Kanfang	23 30.3 N	99 37	Apr 5, 17	....	....	17.6	32 32.0 N	....	....	....	206.12	FB
			Apr 6, 17	6.8, 8.5	0 02.0 E	....	....	7.2, 8.1	.37649	9	....	FB
Wana	23 30.3 N	101 55	Apr 29, 17	8.0	0 06.7 E	6.8	32 29.4 N	8.4	.37751	9	206.12(56)	FB
Mengtsz, *A*	23 28.3 N	103 25	May 11, 17	10.6,14.3	0 02.4 W	15.4	32 33.0 N	11.1,12.0	.37612	9	206.12(56)	FB
Wuchow, *1915*	23 28.0 N	111 17	Jul 20, 15	9.6,11.6	0 23.2 W	15.2	32 43.4 N	10.2,11.1	.37286	9	177.1256	FB
Wuchow, *1917*	23 28.0 N	111 17	Jun 24, 17	10.1,11.9	0 29.0 W	7.5	32 44.3 N	10.6,11.5	.37266	9	206.12(56)	FB
Mongkong	23 27.5 N	110 44	Jun 22, 17	16.7,18.4	0 24.1 W	11.4	32 35.7 N	17.2,18.0	.37348	9	206.12(56)	FB
Sünchow	23 23.4 N	110 03	Jun 20, 17	15.2,17.0	0 33.4 W	11.4,18.5	32 33.9 N	15.9,16.7	.37248	9	206.12(56)	FB
Mengtsz, *B*	23 22.7 N	103 26	May 9, 17	10.6,18.2	0 04.6 W	7.5	32 16.0 N	11.1,17.8	.37751	9	206.12(5)	FB
Kaihwafu	23 22 N	104 12	May 17, 17	8.1,10.0	0 03.6 W	11.2	32 17.5 N	8.6, 9.5	.37658	9	206.12(56)	FB
Swatow	23 21.2 N	116 40	Dec 8, 17	9.6,11.0	0 45.1 W	13.6	32 43.3 N	9.9,10.7	.36805	9	206.12(56)	FB
Tahuan	23 19.6 N	100 05	Apr 9, 17	10.8	0 02.6 E	14.0	32 06.9 N	11.3	.37757	9	206.12(5)	FB
Tungkwan Yun	23 16.9 N	101 24	Apr 25, 17	....	....	18.0	32 05.2 N	....	....	....	206.12(6)	FB
			Apr 26, 17	6.7, 7.8	0 03.8 E	....	....	7.1	.37774	9	....	FB
Loh Fau Shan	23 16.3 N	114 00	Aug 28, 14	....	....	10.7	32 33.0 N	....	....	....	206.12(56)	CKE
			Aug 29, 14	9.9,11.6	0 35.9 W	....	....	10.3,11.3	.37116	12	....	CKE
Lunganhsien	23 10.5 N	107 39	Jun 9, 17	12.6,14.6	0 14.4 W	10.7	31 57.8 N	13.3,14.2	.37632	9	206.12(5)	FB
Mohei	23 09.7 N	101 10	Apr 23, 17	10.2,12.5	0 02.6 W	8.1	31 48.9 N	10.6,11.5	.37862	9	206.12(56)	FB
			Apr 23, 17	....	....	15.4	31 51.2 N	....	....	....	206.1(5)	FB
Poklo	23 09.6 N	114 20	Aug 19, 17	....	....	17.1	32 04.9 N	....	....	....	206.12(56)	FB
			Aug 20, 17	7.6, 9.6	0 36.0 W	....	....	8.1, 9.1	.37116	9	....	FB
Mengpan	23 07.6 N	100 22	Apr 12, 17	16.3,18.0	0 00.4 E	15.3	31 44.4 N	16.7,17.6	.37838	9	206.12(56)	FB
			Apr 13, 17	....	....	7.1	31 47.6 N	....	....	....	206.1(5)	FB
Sheklung	23 07 N	113 58	Aug 26, 17	9.9,12.0	0 28.8 W	15.1	32 05.8 N	10.5,11.6	.37219	12	206.12	CKE
Kweihsien	23 06.9 N	109 35	Jun 17, 17	....	....	17.9	31 57.1 N	....	....	....	206.12(5)	FB
			Jun 19, 17	8.3,11.2	0 17.3 W	....	....	8.8,10.8	.37561	9	....	FB
Canton, *S*	23 06.1 N	113 18	Mar 1, 15	10.8 to 17.2 (7)	0 22.1 W	....	....	11.4,12.3	.37226	9	....	FB
			Mar 1, 15	....	....	....	....	15.1,15.9	.37220	9	....	FB
			Mar 2, 15	10.4,12.3	0 21.0 W	15.6	32 02.6 N	11.0,11.8	.37238	9	177.1256	FB
			Mar 3, 15	....	....	10.6,12.3	32 01.6 N	....	....	....	177.1256	FB
			Mar 4, 15	....	....	10.2	32 01.7 N	....	....	....	177.1256	FB
			Mar 4, 15	....	....	14.5	32 00.9 N	....	....	....	206.1(56)	CKE
			Mar 5, 15	....	....	9.1,11.2	32 01.6 N	....	....	....	206.1(56)	CKE
			Mar 5, 15	....	....	14.9	32 00.4 N	....	....	....	206.1(56)	CKE
			Mar 6, 15	10.8,12.7	0 21.1 W	....	....	11.2,12.2	.37250	12	....	CKE
			Mar 6, 15	14.5,16.6	0 22.4 W	....	....	15.0,16.0	.37242	12	....	CKE
			Mar 10, 15	12.5,14.6	0 23.0 W	....	....	15.2,16.0	.37202	12	....	CKE
			Mar 10, 15	....	....	....	....	16.8,17.5	.37194	12	....	CKE
			Mar 11, 15	12.8,13.1	0 22.6 W	....	....	....	....	12	....	CKE
			Mar 12, 15	10.0,10.3	0 20.2 W	....	....	....	....	12	....	CKE
Canton, *As*	23 05.8 N	113 18	Jul 15, 14	8.3,10.2	0 17.6 W	....	....	8.8, 9.8	.37230	12	....	CKE
			Aug 21, 14	17.0 to 22.8 (dv)	0 21.0 W	....	....	....	....	12	....	CKE
			Aug 22, 14	8.7,11.0	0 21.4 W	15.8	32 03.0 N	9.3,10.4	.37206	12	206.1(56)	CKE
			Jan 14, 15	16.0,16.4,23.8	0 22.7 W	....	....	....	....	12	....	FB
			Jan 15, 15	0.0 to 24.0 (dv)	0 22.4 W	....	....	....	....	12	....	E&B
			Jan 16, 15	9.6	0 20.2 W	....	....	....	....	12	....	FB
			Jan 19, 15	14.4,16.7	0 21.1 W	....	....	15.2,16.2	.37244	12	....	CKE
			Jan 20, 15	....	....	....	....	10.6	.37266	12	....	CKE
			Jan 21, 15	....	....	....	....	10.5(3)	.37257	12	....	CKE
			Jan 22, 15	....	....	....	....	14.1,15.1	.37251	12	....	CKE
			Jan 25, 15	16.9,17.2	0 21.4 W	....	....	14.7,15.6	.37219	12	....	CKE
			Jan 26, 15	9.6 to 11.2 (5)	0 20.6 W	....	....	....	....	12	....	CKE
			Jan 26, 15	12.0	0 24.2 W	....	....	13.9,14.7	.37244	17	....	FB
			Jan 26, 15	15.3,15.7,16.1	0 21.7 W	....	....	....	....	17	....	FB
			Jan 28, 15	9.3,11.1,12.7	0 22.4 W	....	....	9.8,10.6	.37234	17	....	FB
			Jan 28, 15	14.5,14.9,16.8	0 22.0 W	....	....	15.4.16.3	.37226	17	....	FB
			Jan 29, 15	16.1,24.0	0 20.4 W	....	....	....	....	12	....	FB
			Jan 30, 15	0.1 to 24.0 (dv)	0 22.2 W	....	....	....	....	12	....	E&B

ASIA.

CHINA—*Continued.*

Station	Latitude	Long. East of Gr.	Date	Declination: Local Mean Time	Declination: Value	Inclination: L. M. T.	Inclination: Value	Hor. Intensity: L. M. T.	Hor. Intensity: Value	Instruments: Mag'r	Instruments: Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Canton, *A*—*Concluded*	23 05.8 N	113 18	Jan 31, '15	9.0	0 23.0 W					12		FB
			Feb 2, 15			12.0, 15.5	32 02.0 N				206.1(56)	CKE
			Feb 3, 15			10.5	32 00.1 N				206.1(56)	CKE
			Feb 3, 15			14.7	32 02.9 N				172.25(78)	FB
			Feb 4, 15			10.8, 14.5	32 02.5 N				172.25(78)	FB
			Feb 27, 15	11.7 to 17.4 (dv)	0 22.8 W					12		CKE
			Mar 1, 15	10.8 to 17.2 (7)	0 22.5 W			11.4, 12.3	.37265	12		CKE
			Mar 1, 15					15.1, 16.0	.37244	12		CKE
			Mar 2, 15	10.4, 12.3	0 21.0 W	15.6	32 00.9 N	10.9, 11.8	.37260	12	206.1(56)	CKE
			Mar 3, 15			10.6, 12.3	31 59.8 N				206.1(56)	CKE
			Mar 4, 15			10.3	32 00.6 N				206.1(56)	CKE
			Mar 4, 15			14.5	32 02.3 N				177.1256	FB
			Mar 5, 15			9.1, 11.2	32 02.0 N				177.1256	FB
			Mar 5, 15			14.9	32 02.0 N				177.1256	FB
			Mar 5, 15			16.3	32 03.0 N				177.56	FB
			Mar 6, 15	10.8, 12.7	0 22.6 W			11.3, 12.3	.37275	9		FB
			Mar 6, 15	14.5, 16.6	0 23.6 W			15.0, 16.0	.37244	9		FB
			Mar 10, 15	12.4, 14.6	0 23.2 W			16.4 (4)	.37216	9		FB
			Mar 11, 15	12.8, 13.1	0 23.2 W					9		FB
			Mar 12, 15	10.0, 10.3	0 20.4 W					9		FB
			Mar 15, 15	7.4 to 18.0 (dv)	0 19.0 W					12		B&I
			Mar 17, 15			10.2, 12.3	32 00.8 N				172.25(78)	CKE
			Mar 18, 15			10.4	32 00.3 N				172.25(78)	CKE
			Mar 18, 15			12.0, 14.6	32 01.3 N				177.1256	FB
			Mar 19, 15			14.3	32 03.2 N				177.1256	FB
			Apr 15, 15	8.2 to 17.8 (dv)	0 24.0 W					12		CKE
			May 1, 15	6.4 to 18.0 (dv)	0 23.2 W					12		CKE
			May 15, 15	6.5 to 16.0 (dv)	0 23.5 W					12		CKE
			Jun 1, 15	7.8 to 14.2 (dv)	0 23.3 W					12		CKE
			Jun 1, 15	16.2	0 23.4 W					12		CKE
			Jul 15, 15	6.5 to 16.6 (dv)	0 24.9 W					12		CKE
			Jul 23, 15			10.5	32 03.1 N				177.1256	FB
			Jul 26, 15	6.2, 11.3	0 23.2 W			6.9, 10.7	.37270	12		CKE
			Jul 26, 15	16.3, 18.4	0 24.2 W			16.9, 17.9	.37222	12		CKE
			Jul 27, 15	6.0, 18.4	0 22.2 W			6.9, 17.8	.37220	12		CKE
			Jul 28, 15	6.2, 8.3	0 20.0 W			6.9, 7.9	.37209	9		FB
			Jul 28, 15	16.9, 18.8	0 22.8 W			17.4, 18.3	.37196	9		FB
			Jul 29, 15	9.6, 9.9	0 21.9 W			6.6, 7.5	.37212	9		FB
			Jul 30, 15					6.3	.37225	9		FB
			Jul 30, 15	9.5	0 21.2 W			7.4, 10.0	.37237	12		CKE
			Jul 31, 15			9.0	32 02.6 N				206.12(56)	FB
			Dec 13, 17			9.4 to 16.4 (10)	32 00.3 N				EI 24	CKE
			Dec 14, 17			9.1, 9.6	32 01.2 N				EI 24	CKE
			Dec 16, 17	11.8, 12.3	0 28.8 W					9		FB
			Dec 16, 17	14.6 to 15.8 (4)	0 29.6 W					9		FB
			Dec 17, 17	9.2 to 12.4 (8)	0 30.4 W					24		CKE
			Dec 19, 17					10.2, 12.7	.37190	24		FB
			Dec 19, 17					15.0, 17.3	.37178	24		FB
			Dec 20, 17					8.6, 11.0	.37256	24		FB
			Dec 20, 17					13.6, 16.0	.37226	24		FB
			Dec 21, 17					7.9, 10.3	.37199	24		FB
			Dec 21, 17					11.1, 14.5	.37232	24		FB
			Dec 21, 17					15.7	.37237	24		FB
			Dec 22, 17					8.5	.37210	24		FB
			Dec 24, 17					8.1	.37224	9		FB
			Dec 24, 17					10.3, 11.0	.37246	9		FB
			Dec 24, 17					14.6, 15.8	.37230	9		FB
			Dec 26, 17					9.1, 9.8	.37228	9		FB
			Dec 26, 17					12.1, 14.1	.37246	9		FB
			Dec 26, 17					16.4	.37205	9		FB
			Dec 27, 17					9.5, 11.7	.37243	9		FB
Canton, *B*	23 05.8 N	113 18	Jul 13, 14	10.6, 13.4	0 20.0 W	17.5	32 02.7 N	11.6, 13.0	.37251	12	206.(56)	CKE
			Jan 19, 15	14.4, 16.7	0 22.3 W			15.2, 16.2	.37260	17		FB
			Jan 20, 15					10.6, 11.9	.37254	17		FB
			Jan 21, 15					10.4 (3)	.37246	17		FB
			Jan 22, 15					14.1, 15.1	.37256	17		FB
			Jan 25, 15	16.9, 17.2	0 22.4 W			14.7, 15.6	.37224	17		FB
			Jan 26, 15	9.6 to 11.2 (5)	0 22.1 W					17		FB
			Jan 26, 15	12.0	0 22.6 W			13.9, 14.7	.37236	12		CKE
			Jan 26, 15	15.3, 15.7, 16.1	0 21.3 W					12		CKE

ASIA.

CHINA—*Concluded.*

Station	Latitude	Long East of Gr	Date	Declination: Local Mean Time	Declination: Value	Inclination: L M T	Inclination: Value	Hor Intensity: L M T	Hor Intensity: Value	Instruments: Mag'r	Instruments: Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c g s			
Canton, B—*Concluded*	23 05 8 N	113 18	Jan 28, '15	9 3 to 16 8 (6)	0 20 5 W			9 8,10 6	37233	12		CKE
			Jan 28, 15					15 4,16 3	37224	12		CKE
			Feb 2, 15			12 0,15 5	32 03 6 N				172 25(78)	FB
			Feb 3, 15			10 5	32 02 0 N				172 25(78)	FB
			Feb 3, 15			14 7	32 02 1 N				206 1(56)	CKE
			Feb 4, 15			10 8,14 5	32 01 2 N				206 1(56)	CKE
			Mar 17, 15			10 2,12 3	32 01 9 N				177 1256	FB
			Mar 18, 15			10 4	32 01 5 N				177 1256	FB
			Mar 18, 15			11 9,14 6	32 00 8 N				172 25(78)	CKE
			Mar 19, 15			14 3	32 02 4 N				172 25(78)	CKE
			Jul 26, 15	6 2,11 3	0 21 6 W			6 9,10 7	37222	9		FB
			Jul 26, 15	16 3,18 4	0 22 8 W			16 9,18 1	37214	9		FB
			Jul 27, 15	6 0,18 4	0 21 0 W			6 9,17 8	37204	9		FB
			Jul 28, 15	6 2, 8 3	0 19 8 W			7 0, 7 8	37198	12		CKE
			Jul 28, 15	16 9,18 8	0 22 8 W			17 4,18 3	37204	12		CKE
			Jul 29, 15	9 6, 9 8	0 21 4 W			6 6, 7 5	37217	12		CKE
			Jul 30, 15					6 2	37233	12		CKE
			Jul 30, 15	9 5	0 19 9 W			7 5,10 0	37225	9		FB
			Jul 2, 17	5 8 to 18 2 (dv)	0 28 1 W					9		FB
			Jul 3, 17	8 0,10 0	0 26 4 W	16 4	32 00 7 N	8 6, 9 6	37284	9	206 12(56)	FB
			Aug 1, 17	5 8 to 18 2 (dv)	0 27 8 W					9		FB
			Aug 15, 17	5 8 to 18 2 (dv)	0 27 8 W					9		FB
			Aug 16, 17	14 3,17 5	0 29 4 W			14 8,15 7	37238	9		FB
			Aug 17, 17			6 6	32 03 4 N				206.12(56)	FB
			Dec 14, 17			11 6 (4)	32 00 8 N				EI 24	CKE
			Dec 15, 17			8 0 to 16 3 (12)	32 00 3 N				EI 24	CKE
			Dec 16, 17	11 8,12 3	0 26 9 W					24		CKE
			Dec 16, 17	14 6 to 15 8 (4)	0 27 5 W					24		CKE
			Dec 17, 17	9 2 to 12 4 (8)	0 29 8 W					9		FB
			Dec 19, 17					11 1,11 9	37219	9		FB
			Dec 19, 17					15 8,16 6	37179	9		FB
			Dec 20, 17					9 4,10 2	37259	9		FB
			Dec 20, 17					14 4,15 2	37222	9		FB
			Dec 21, 17					8 7, 9 6	37214	9		FB
			Dec 21, 17					11 8,13 7	37231	9		FB
			Dec 21, 17					16 4	.37215	9		FB
			Dec 22, 17					7 7	.37211	9		FB
			Dec 24, 17					8 8	.37246	24		FB
			Dec 24, 17					9 6,11 7	37249	24		FB
			Dec 24, 17					13 8,16 5	37228	24		FB
			Dec 24, 17					17 3	37218	24		FB
			Dec 26, 17					8 4,10 6	.37230	24		FB
			Dec 26 17					11 4,14 8	.37251	24		FB
			Dec 26, 17					15 7	37225	24		FB
			Dec 27, 17					10 2,11 0	37252	24		FB
Nanning	22 48 1 N	108 16	Jun 12, 17	6 7, 8 5	0 09 9 W	11 3,16 2	31 18 0 N	7 2, 8 1	37704	9	206 2(5)	FB
Wingshun	22 47.2 N	108 52	Jun 15, 17	14 3,16 0	0 15 1 W	10 7	31 18 0 N	14 7,15 6	.37668	9	206 12(56)	FB
			Jun 16, 17	5 6 to 18 2 (dv)	0 13 9 W					9		FB
Szemao	22 47 1 N	100 59	Apr 18, 17	9 3,11 8	0 00 6 W	15 1	31 03 2 N	9 8,11 0	37986	9	206 12(56)	FB
Shekki	22 32 N	113 23	Jul 17, 14	12 7,13 1,14 2	0 20 4 W	8 2	30 54 9 N	13 6	.37439	12	206 12(56)	CKE
Hongkong Observatory, *North Pier* or *A*	22 19 2 N	114 10	Feb 21, 15	15 8,16 0	0 08 8 W					9		FB
			Feb 22, 15	12 4,14 1	0 10 1 W					9		FB
			Feb 22, 15	15 2,16 0	0 09 2 W					9		FB
			Feb 22, 15	17.2,17 4	0 07 5 W					9		FB
			Feb 24, 15					12 0	.37217	9		FB
			Feb 24, 15					15 2,16 8	37198	9		FB
Hongkong Observatory, *South Pier* or *A′*	22 19 2 N	114 10	Feb 17, 15			11 3	30 49.1 N				177 1256	FB
			Feb 18, 15			11 0,15 1	30 51 2 N				177 1256	FB
			Feb 19, 15			9 4,16 3	30 50 6 N				177 1256	FB
Hongkong Observatory, *Tent* or *B*	22 19 2 N	114 10	Feb 10, 15	15 0	0 14 7 W					9		FB
			Feb 12, 15	11 6,12 0	0 14 5 W					9		FB
			Feb 13, 15	10 1 to 11 8 (4)	0 14 5 W					9		FB
			Feb 13, 15	15 4	0 13 0 W					9		FB
			Feb 15, 15			11 8,14 6	30 49.8 N				177 1256	FB
			Feb 16, 15			11.6,14 5	30 49 4 N				177 1256	FB
			Feb 25, 15					9 4,11 0	37244	9		FB
			Feb 25, 15					12 9,15 3	37244	9		FB
			Feb 25, 15					16 7	37241	9		FB
Macau	22 13 N	113 32	Jul 20, 14	6 0, 8 2	0 15 9 W	11 7	30 38 2 N	7 0, 7 8	37434	12	206 12(56)	CKE

ASIA.

INDIA.

Station	Latitude	Long. East of Gr.	Date	Declination: Local Mean Time	Declination: Value	Inclination: L. M. T.	Inclination: Value	Hor. Intensity: L. M. T.	Hor. Intensity: Value	Instruments: Mag'r	Instruments: Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Kulonghka	24 24.2 N	97 31	Feb 27, '17	16.2, 17.8	0 10.3 W	....	....	16.6, 17.4	.37444	9	....	FB
			Feb 28, 17	....	....	8.3	33 49.7 N	....	....	.....	206.12(56)	FB
Bhamo	24 15.4 N	97 14	Mar 2, 17	5.9 to 18.2 (dv)	0 08.8 E	....	....	....	....	9	....	FB
			Mar 3, 17	....	....	8.8	33 55.5 N	....	....	.....	206.12(56)	FB
			Mar 10, 17	9.6, 11.4	0 11.4 E	17.0	33 56.9 N	10.1, 11.0	.37493	9	206.12(56)	FB

JAPAN.

Station	Latitude	Long. East of Gr.	Date	Declination: Local Mean Time	Declination: Value	Inclination: L. M. T.	Inclination: Value	Hor. Intensity: L. M. T.	Hor. Intensity: Value	Instruments: Mag'r	Instruments: Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Sugita	35 22.7 N	139 38	Dec 9, '18	11.1, 11.4, 13.2	5 23.1 W	15.7	48 31.5 N	11.9, 12.8	.29950	17	228.1356	HES

SIBERIA.

Station	Latitude	Long. East of Gr.	Date	Declination: Local Mean Time	Declination: Value	Inclination: L. M. T.	Inclination: Value	Hor. Intensity: L. M. T.	Hor. Intensity: Value	Instruments: Mag'r	Instruments: Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Port Dickson	73 30.2 N	80 26	Sep 2, '18	12.5, 20.2	28 41 E	....	....	16.5, 19.8	.07512	8	....	HUS
			Sep 3, 18	18.2	28 48 E	19.4	82 37.7 N	20.0	.07485	*205*	205.123	HUS

STRAITS SETTLEMENTS.

Station	Latitude	Long. East of Gr.	Date	Declination: Local Mean Time	Declination: Value	Inclination: L. M. T.	Inclination: Value	Hor. Intensity: L. M. T.	Hor. Intensity: Value	Instruments: Mag'r	Instruments: Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Singapore, *Botanical Gardens*	1 18.9 N	103 48	Dec 30, '14	15.4	0 39.6 E	13.8	16 55.7 S	15.9	.38786	17	177.1256	FB
			Dec 31, 14	9.6, 11.2	0 37.7 E	12.0	16 54.8 S	10.1, 10.9	.38833	17	177.16	FB
			Nov 8, 18	16.2, 17.0	0 34.4 E	....	....	16.6	.38845	17	....	HES
			Nov 9, 18	....	....	9.3	17 10.0 S	....	....	.....	223.1356	HES
Singapore, *Holland Road*	1 16 N	103 48	Nov 12, 18	14.9, 16.4	0 36.8 E	....	....	15.3, 16.0	.38771	17	....	HES
			Nov 13, 18	....	....	9.5	17 14.8 S	....	....	.....	223.1356	HES

AUSTRALASIA.

AUSTRALIA.

Station	Latitude	Long. East of Gr.	Date	Declination: Local Mean Time	Declination: Value	Inclination: L. M. T.	Inclination: Value	Hor. Intensity: L. M. T.	Hor. Intensity: Value	Instruments: Mag'r	Instruments: Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Bramble Cay	9 08 S	143 52	Nov 15, '15	18.0	(4 57 E)[1]	....	....	....	....	14	....	WCP
Thursday Island, *A*	10 34.9 S	142 12	Nov 11, 15	16.1 to								
			Nov 12, 15	12.7 (dv)	4 54.5 E	14.9	33 27.7 S	13.0, 13.6	.36780	14	14.1256	WCP
			Nov 12, 15	14.0	4 56.9 E	....	....	....	....	14	....	WCP
Cape Croker	10 58.4 S	132 32	Aug 12, 14	....	....	16.9	35 23.3 S	....	....	.....	172.25(78)	FB
			Aug 13, 14	8.8, 10.6	3 42.2 E	....	....	9.3, 10.2	.36721	17	....	FB
Cape Wessel	11 00.7 S	136 45	Aug 30, 14	14.2, 15.9	4 08.4 E	11.1	34 51.4 S	14.7, 15.5	.36698	17	172.25(78)	FB
Cape Wessel, *Secondary*	11 00.7 S	136 45	Aug 30, 14	9.6	4 07.0 E	....	....	....	....	*178*	....	FB
Piper Head	11 16.3 S	130 23	May 6, 14	9.3, 11.0	3.10 1 E	13.2	36 08.3 S	9.8, 10.6	.36590	17	172.25(7)	FB
Brenton Bay	11 18.4 S	131 13	Sep 13, 14	....	....	16.5	36 06.3 S	....	....	.....	172.25(78)	FB
			Sep 14, 14	8.6, 10.6, 10.8	3 26.7 E	....	....	9.2, 10.2	.36643	17	....	FB
Cape Cockburn	11 20.4 S	132 52	Aug 17, 14	9.6, 11.4	3 58.7 E	15.1	36 01.2 S	10.1, 11.0	.36540	17	172.25(78)	FB
Bowen Straits Aboriginal Station	11 20.6 S	132 33	Sep 11, 14	10.0, 14.2	3 47.6 E	16.3	36 09.9 S	10.4, 11.4	.36592	17	172.25(7)	FB
			Sep 11, 14	....	....	....	....	14.7	.36578	17	....	FB
Victoria	11 22.5 S	132 08	Aug 10, 14	14.4, 16.3	3 27.6 E	10.2	36 23.7 S	15.0, 15.9	.36566	17	172.25(78)	FB
Bynoe	11 45.3 S	130 40	May 9, 14	....	....	17.3	37 02.2 S	....	....	.....	172.25	FB
			May 10, 14	8.0, 9.2	3 24.8 E	....	....	8.6	.36341	17	....	FB
Mission Station (Bathurst Island)	11 45.5 S	130 39	May 4, 14	10.5, 13.7	3 27.4 E	8.6	37 01.5 S	10.9, 12.7	.36340	17	172.25(78)	FB
Bromby's Islands	11 51.9 S	136 34	Sep 2, 14	14.0, 16.0	4 10.1 E	9.0	36 24.2 S	14.5, 15.6	.36476	17	172.25(78)	FB
Bromby's Islands, *Secondary*	11 51.9 S	136 34	Sep 2, 14	11.5	4 08.2 E	....	....	....	....	*178*	....	FB

[1] Azimuth from chart.

AUSTRALASIA.

AUSTRALIA—*Continued.*

Station	Latitude	Long East of Gr	Date	Declination		Inclination		Hor Intensity		Instruments		Obs'r
				Local Mean Time	Value	L. M T	Value	L M. T	Value	Mag'r	Dip Circle	
	° ′	° ′		h h h	° ′	h h	° ′	h h	c g s			
Alger Island	11 53 6 S	135 57	Sep 6, '14	8 9,10.8	4 06.6 E	14 7	36 37 4 S	9 4,10 3	36472	17	172 25(78)	FB
			Sep 6, 14					11 2	36470	17		FB
Twenty-Mile Landing	11 54 7 S	133 24	Aug 20, 14	10 2,11.7	3 43.0 E	8 4	36 53 0 S	10 6,11 4	36444	17	172 25(78)	FB
Cape Hotham	12 04 0 S	131 16	Jul 16, 14	13 9,15 6	3 22.6 E	10 7	37 24 5 S	14 4,15 2	36346	17	172 25(78)	FB
Cadell's Landing	12 06 3 S	134 11	Aug 22, 14	13 9,15 5	3 52.0 E	17 2	37 07.5 S	14 3,15 1	36416	17	172 25(78)	FB
Cadell's Landing, *Secondary*	12 06 3 S	134 11	Aug 22, 14	11 6	3 50.7 E					*172*		FB
Connell's Creek	12 17 4 S	131 32	Jul 31, 14			15 4	37 51 2 S				172 25(78)	FB
			Aug 1, 14	8 9,11.0	3 28 4 E			9 5,10 4	36180	17		FB
Goyder River	12 18 7 S	135 13	Aug 25, 14	13 8,15.8	3 59.3 E	11 3	37 20 6 S	14 2,15 2	.36308	17	172 25(78)	FB
			Aug 25, 14					15 6	36329	17		FB
Goyder River, *Secondary*	12 18 7 S	135 13	Aug 25, 14	16 7	4 01.9 E					*172*		FB
Oenpelli	12 19 8 S	133 02	Jul 25, 14	17 2	3 49.6 E	10 1	37 31 6 S	15 4,16 8	36587	17	172 25(78)	FB
			Jul 26, 14	9 6,11.3	3 49 4 E			10 1,10 9	36600	17		FB
Oenpelli, *Secondary*	12 19 8 S	133 02	Jul 26, 14	16 6	3 44.8 E					*172*		FB
Cahill's Landing	12 21 4 S	132 57	Jul 24, 14					14 3	36246	17		FB
			Jul 27, 14	11 7	3 51.4 E	13 3	37 34 9 S	12 2	36253	17	172 2	FB
Point Charles Lighthouse	12 23.4 S	130 39	Oct 3, 14			15 2	38 05 2 S				172 25(78)	FB
			Oct 4, 14	10 0,11.5,17 1	3 25.4 E			10 4,11 2	36212	17		FB
			Oct 4, 14	17 3 to								
			Oct 5, 14	17 3 (dv)	3 25.0 E					17		FB
			Oct 6, 14			10 4	38 03 3 S				172 25	FB
Point Charles Lighthouse, *Secondary*	12 23 4 S	130 39	Oct 3, 14	13 8	3 27.0 E					*172*		FB
Arnhem Bay	12 26 6 S	136 03	Sep 4, 14	13 4,15.2,15 5	4 08.0 E	11 1,16 9	37 25 6 S	13 9,14 8	36300	17	172 25(78)	FB
Darwin	12 26 7 S	130 50	May 19, 14	11 0,12 8	3 25.2 E	14 4	38 11 4 S	11 5,12 4	36178	17	172 25(78)	FB
Batchelor	13 03 6 S	131 03	May 14, 14	14 2,15 8	3 30.4 E			14 6,15 4	35870	17		FB
			May 15, 14			8 4	39 06 6 S				172 25(78)	FB
Pine Creek, *A*	13 49 6 S	131 51	Apr 28, 14	14 0,15.7	3 34.0 E	11 9	40 07 4 S	14 4,15 3	35757	17	172 25(7)	FB
Pine Creek, *B*	13 49 6 S	131 51	Apr 29, 14	13 9,15 6	3 33.6 E	11 6	40 10 2 S	14 4,15 2	35772	17	172 25(78)	FB
Katherine River	14 26 1 S	132 17	Apr 25, 14	14 3,16.0	3 41.8 E	10 8	41 14 1 S	14 8,15 6	35508	17	172 25(78)	FB
Mission Station (Roper River)	14 44 9 S	134 50	Jun 8, 14	9 6,11 4	4 02.5 E	15 5	41 21 0 S	10 1,11 0	35624	17	172 25(78)	FB
Port George IV.	15 21 1 S	124 43	Sep 24, 14	8 6,10 2	2 18 8 E			9 0, 9 9	34792	14		WCP
			Sep 26, 14			11 0	43 34 4 S				14 1256	WCP
Victoria River	15 24 5 S	130 02	Apr 8, 14	10 9,11 8	3 08 0 E	13 1	43 03 0 S	11 3	35099	17	172 25	FB
Six-Mile Hotel	15 29 8 S	128 08	Sep 20, 14	15 3,16 7	2 59 2 E			15 7,16 4	34868	24		EK
			Sep 21, 14			7 9	43 20 5 S				EI 24	EK
Sir Edward Pellew Islands	15 35 1 S	136 43	Jun 23, 14	13 9,14 9	4 20 7 E	13 1	42 21 7 S	14 3	35319	17	172 25	FB
Depot	15 37 0 S	130 27	Apr 13, 14	9 9,11 6	3 18 0 E	7 6	43 25 2 S	10 4,11 3	34964	17	172 25(78)	FB
Timber Creek	15 38 1 S	130 29	Apr 14, 14	14 7	3 19 1 E	13 9	43 26 0 S	15 2	34929	17	172 25	FB
Delamere	15 44 1 S	131 32	Apr 19, 14	10 6	3 30 9 E	8 5	43 18 8 S	11 1	35025	17	172.25	FB
Cheese Tin	15 49 8 S	128 20	Sep 17, 14	16 7	2 54 5 E	16 0	43 56 1 S	17 0	34800	24	EI 24	EK
Montgomery Islands	15 53 7 S	124 18	Sep 29, 14	8 3, 9 4	2 14 4 E	10 6	44 39 0 S	8 6, 9 2	34404	14	14 1256	WCP
Black Rocks	15 56 4 S	136 31	Jun 22, 14	10 3,11 5	4 16 4 E	13 5	13 04 6 S	10 8	35151	17	172 2	FB
Five-Mile Bar	16 00 2 S	136 24	Jun 17, 14	13 5,15 2	4 16 6 E	11 1	43 09 3 S	13 9,14 8	35107	17	172 2(78)	FB
Borroloola	16 04 2 S	136 22	Jun 13, 14	14 1,15 7	4 17 1 E			14 5,15 3	35066	17		FB
			Jun 14, 14			10 4	43 17 1 S				172 25(78)	FB
Ryan's Bend	16 08 2 S	136 08	Jun 15, 14	14 0,15 6	4 13 0 E	8 1	43 29 6 S	14 4,15 2	31982	17	172 25(78)	FB
Wild Dog Spring	16 14 1 S	128 21	Sep 15, 14	14 1,15 3	2 55 0 E	13 2	44 28 5 S	14 4,15 0	34598	24	EI 24	EK
Sunday Island	16 24 5 S	123 12	Oct 4, 14	9 2,10 5	2 05 6 E	11 4	15 28 7 S	9 5,10 2	34121	14	14 1256	WCP
Bow Creek	16 39 8 S	128 12	Sep 13, 14	16 5	2 44 1 E	15 6	45 14 6 S	16 9	34452	24	EI 24	EK
Turkey Creek	17 01 9 S	128 13	Sep 11, 14	9 3,10 5	2 06 2 E	11 3	45 50 3 S	9 6,10 2	34481	24	EI 24	EK
Derby	17 17 8 S	123 38	Sep 9, 14	13 5,14 7	2 08 5 E			13 8,14 4	33787	14		WCP
			Sep 10, 14			10 1	46 43 4 S				14 1256	WCP
Fourteen-Mile Creek	17 44 8 S	127 52	Sep 7, 14	12 4	2 45 7 E	15 0	46 45 4 S	12 8	33897	24	EI 24	EK
Rosie's Creek	17 47 3 S	127 48	Sep 5, 14	14 4	2 41 7 E	15 8	46 56.3 S	14 7	33876	24	EI 24	EK
Broome, *B*	17 58 1 S	122 13	Oct 12, 14	9 4 to								
			Oct 13, 14	9 6 (dv)	1 56 4 E					14		WCP
Broome, *A*	17 58 4 S	122 13	Sep 7, 14	14 2,15 4	1 49 7 E	16 1	47 59 0 S	14 6,15 2	33260	14	14.1256	WCP
Moola Bulla	18 11 8 S	127 28	Sep 2, 14	15 0,16 2	2 31 2 E	17 1	47 42 4 S	15 4,15 9	33598	24	EI 24	EK
Hall's Creek	18 15.3 S	127 46	Aug 25, 14	11 5,15 6	2 24 1 E	10 0,10 4	47 37 9 S	11 8,15 1	33546	24	EI 24	EK
Flora Valley	18 16 0 S	127 59	Aug 18, 14	10 4,11 5	2 31 2 E	9 7	48 01 7 S	10 7,11 2	33580	24	EI 24	EK
Cow Creek	18 38 5 S	128 22	Aug 14, 14			20 2	48 15 3 S				EI 24	EK
			Aug 15, 14	7 8	2 52 3 E			8 2	33428	24		EK
Sturt Creek	19 08 2 S	128 13	Aug 12, 14	16 5	2 47 3 E	17 8	48 45 8 S	16 9	33220	24	EI 24	EK
Wolf Creek	19 22 3 S	127 48	Aug 10, 14	9 3,10.7	2 35 4 E	11 7	49 12 1 S	9 7,10 4	33047	24	EI 24	EK
Cutharra Pools	19 43 5 S	127 34	Aug 7, 14	16 7	2 33 6 E	15 9	49 49 7 S	17 0	32730	24	EI 24	EK
Lungan Pool	20 01 4 S	127 26	Aug 5, 14	16 5	2 34 7 E	17 6	50 12 7 S	16 8	32614	24	EI 24	EK
Well No 50	20 12 8 S	127 01	Aug 3, 14	16 4	2 36 6 E	17 7	50 31 5 S	16 7	32457	24	EI 24	EK
Well No 48	20 15 2 S	126 35	Jul 31, 14	16 2,17 4	2 13 6 E	19 8,20 1	50 51 7 S	16 6,17 2	32106	24	EI 24	EK

AUSTRALASIA.

AUSTRALIA—*Continued.*

Station	Latitude	Long. East of Gr.	Date	Declination		Inclination		Hor. Intensity		Instruments		Obs'r
				Local Mean Time	Value	L. M. T.	Value	L. M. T.	Value	Mag'r	Dip Circle	
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Port Hedland	20 18.7 S	118 35	Aug 31, '14	9.4,10.9	0 22.6 E	11.6,14.8	51 40.8 S	9.8,10.6	.31742	14	14.1256	WCP
Kudarra	20 38.4 S	126 20	Jul 29, 14	14.7	2 16.8 E	16.6	51 07.1 S	15.1	.32280	24	EI 24	EK
Ballaballa	20 41.4 S	117 49	Sep 3, 14	9.6,10.9	0 17.8 E	8.2	52 21.0 S	10.0,10.6	.31346	14	14.1256	WCP
Pijallinga Claypan	20 54.5 S	126 10	Jul 27, 14	16.4	2 11.8 E	15.6	51 26.5 S	16.7	.32127	24	EI 24	EK
Marble Bar	21 11.4 S	119 44	Aug 27, 14	9.2,10.5	1 33.4 E	11.3	52 40.5 S	9.5,10.1	.31482	14	14.1256	WCP
			Aug 27, 14			14.9	52 40.1 S				14.5	WCP
Billowaggi	21 13.8 S	125 59	Jul 24, 14			17.6,19.2	51 52.0 S				EI 24	EK
			Jul 25, 14	9.5,10.9	2 03.8 E			9.9,10.6	.32000	24		EK
Guli	21 19.5 S	125 53	Jul 23, 14			10.5	52 05.7 S				EI 24	EK
			Jul 24, 14	8.2	2 02.7 E			8.6	.31938	24		EK
Wadawalla	21 40.3 S	125 47	Jul 21, 14	16.6	1 58.8 E	15.7	52 31.9 S	17.0	.31702	24	EI 24	EK
Nullagine	21 53.0 S	120 07	Aug 20, 14	14.2,15.4	0 49.2 E	16.6	53 34.8 S	14.5,15.1	.30823	14	14.1256	WCP
Wardabunna	21 57.8 S	125 31	Jul 19, 14	16.2	1 53.7 E	14.2	52 53.3 S	16.6	.31538	24	EI 24	EK
Wanda	22 08.4 S	125 15	Jul 16, 14			17.3	53 09.0 S				EI 24	EK
			Jul 17, 14	8.1	1 51.9 E			8.4	.31436	24		EK
Spinifex Camp	22 18.2 S	124 47	Jul 14, 14	15.6	1 55.5 E	16.9	53 24.4 S	15.9	.31320	24	EI 24	EK
Well No. 31	22 31.7 S	124 21	Jul 11, 14			17.9	53 57.9 S				EI 24	EK
			Jul 12, 14	9.2,10.5	1 32.4 E			9.5,10.2	.31088	24		EK
Well No. 29	22 33.4 S	123 48	Jul 9, 14	13.9	1 27.6 E	15.6	53 51.3 S	14.4	.31124	24	EI 24	EX
Well No. 27	22 47.8 S	123 34	Jul 7, 14			17.3	54 17.6 S				EI 24	EK
			Jul 8, 14	8.2	0 55.2 E			8.5	.31014	24		EK
Ethel Creek	22 54.5 S	120 10	Aug 17, 14	10.2,11.4	0 23.2 E	13.6	55 10.5 S	10.5,11.1	.30168	14	14.1256	WCP
Karara Soaks	23 06.8 S	123 18	Jul 5, 14	11.0	0 52.3 E	10.0	55 10.6 S	11.3	.30365	24	EI 24	EK
Well No. 21	23 10.8 S	122 44	Jul 2, 14	15.4	1 09.7 E	16.6	54 47.1 S	15.8	.30535	24	EI 24	EK
Rockhampton	23 22.0 S	150 30	Mar 25, 14	14.5,16.2	8 03.4 E	11.7	51 12.2 S	15.1,15.8	.32525	17	172.25(78)	FB
Well No. 19	23 25.2 S	122 28	Jun 30, 14			16.5	55 12.3 S				EI 24	EK
			Jul 1, 14	7.8	1 10.4 E			8.2	.30313	24		EK
Water No. 17	23 43.5 S	122 27	Jun 28, 14	10.0,11.3	0 50.0 E	9.0, 9.3	55 34.5 S	10.4,11.0	.30160	24	EI 24	EK
Mundawindi	23 53.4 S	120 10	Aug 16, 14	8.9,10.5	0 07.6 E	11.9	56 10.2 S	9.3,10.1	.29651	14	14.1256	WCP
Well No. 15	24 08.4 S	122 10	Jun 25, 14			17.0	56 09.3 S				EI 24	EK
			Jun 26, 14	7.8	0 51.5 E			8.2	.30006	24		EK
Well No. 13	24 25.5 S	121 57	Jun 23, 14			20.3	56 48.5 S				EI 24	EK
			Jun 24, 14	8.4	0 39.6 E			8.9	.29585	24		EK
Goodwin Soak	24 44.6 S	121 43	Jun 21, 14	10.6,12.0	0 33.6 E	9.6,10.0	57 13.6 S	11.0,11.7	.29092	24	EI 24	EK
Bald Hill	24 49.5 S	119 36	Aug 14, 14	13.1,14.6	0 20.8 W	16.3	57 05.5 S	13.5,14.3	.29617	14	14.1256	WCP
Carnarvon	24 53.2 S	113 39	Dec 13, 14	14.0,15.1	2 22.1 W	10.7	58 01.8 S	14.6	.28275	17	177.1256	FB
Weld Spring	25 01.2 S	121 33	Jun 18, 14	15.8	0 43.2 E	19.8	57 05.9 S	16.2	.29511	24	EI 24	EK
Well No. 7	25 09.7 S	121 17	Jun 16, 14	15.5	0 11.4 E	17.5	57 09.7 S	15.9	.29439	24	EI 24	EK
Well No. 5	25 22.8 S	121 01	Jun 14, 14			19.9	57 46.2 S				EI 24	EK
			Jun 15, 14	7.8	0 22.1 W			8.2	.28916	24		EK
Well No. 4	25 37.2 S	120 33	Jun 11, 14	13.0,14.5	0 21.0 E	10.7,11.3	57 24.3 S	13.5,14.2	.29335	24	EI 24	EK
Peak Hill	25 37.6 S	118 44	Aug 12, 14			16.5	58 02.1 S				14.1256	WCP
			Aug 13, 14	9.0,10.4	0 10.8 W			9.4,10.1	.28600	14		WCP
Birdsville	25 54.3 S	139 21	Jun 9, 14	13.8,15.4	5 20.4 E			14.3,15.1	.30286	9		ALK
			Jun 10, 14			9.9,10.5	56 09.5 S				41.5(12)	ALK
Water No. 2A	26 00.9 S	120 20	Jun 8, 14	16.2	0 29.8 W	15.4	58 40.5 S	16.5	.28489	24	EI 24	EK
Miranda	26 03.9 S	139 52	Jun 6, 14	13.7,15.4	5 28.0 E	9.9,10.7	56 20.7 S	14.2,14.9	.30206	9	41.5(12)	ALK
Cadelga	26 05.5 S	140 24	Jun 3, 14	13.4,15.3	5 37.4 E	9.8,10.5	56 20.7 S	14.0,14.8	.30148	9	41.5(12)	ALK
Carthole Water-Hole	26 20.9 S	139 15	Jun 12, 14	13.3,15.1	5 17.2 E	9.5,10.2	56 49.7 S	13.8,14.6	.29962	9	41.5(12)	ALK
Haddon Downs	26 21.0 S	140 50	May 31, 14	13.4,15.5	5 42.4 E	10.0,10.8	56 32.8 S	14.0,15.0	.30092	9	41.5(12)	ALK
Kookabubba Well	26 21.2 S	120 18	Jun 6. 14	15.0	0 34.4 W	16.8	58 54.3 S	15.4	.28312	24	EI 24	EK
Wiluna	26 34.7 S	120 14	Jun 3, 14	10.7,11.9	0 25.6 W	9.4,10.0	59 01.0 S	11.0,11.7	.28187	24	EI 24	EK
Meekatharra	26 35.2 S	118 30	Aug 11, 14	13.1,14.3	1 06.8 W	11.1	59 02.4 S	13.4,14.0	.28058	14	14.1256	WCP
Cordillo Downs	26 42.9 S	140 38	May 27, 14	13.6,15.4	5 42.5 E			14.1,15.0	.29844	9		ALK
			May 28, 14			9.9,10.6	57 02.3 S				41.5(12)	ALK
Abercromby Well	26 51.6 S	120 20	May 31, 14	17.1	0 32.7 W	16.4	59 31.1 S	17.4	.28008	24	EI 24	EK
Moorilyanna	26 52.2 S	133 01	Sep 25, 14	13.6,17.5	3 19.6 E			14.5,16.9	.29121	6		GFD
			Oct 1, 14			13.3	58 22.4 S				38.12	GFD
Moorilyanna, *Secondary*	26 52.5 S	133 01	Oct 1, 14	17.1,17.8	3 44.2 E			17.3	.28678	6		GFD
			Oct 2, 14			17.2	58 51.0 S				38.12	GFD
Goyder's Lagoon	26 56.7 S	138 57	Jun 15, 14	13.3,15.3	5 14.4 E			13.8,14.8	.29598	9		ALK
			Jun 16. 14			9.9,10.6	57 27.1 S				41.5(12)	ALK
Wantapella	27 00.9 S	133 28	Sep 17, 14	13.5,16.8	3 31.4 E			14.3,16.3	.29184	6		GFD
			Oct 10, 14			16.2	58 14.5 S				38.12	GFD
Todmorden	27 08.5 S	134 45	Sep 7, 14	16.2	4 01.1 E			17.4	.29243	6		GFD
			Sep 8, 14			16.2	58 09.4 S				38.12	GFD
Logan Well	27 15.7 S	120 28	May 29, 14			18.3	59 52.3 S				EI 24	EK
			May 30, 14	7.8	0 33.8 W			8.1	.27759	24		EK
Musgrave Range[1]	27 16 S	134 01	Sep 10 to Nov 1, 14		3 41 E					Compass		GFD

[1] Mean of 20 stations at which approximate determinations of declination were made with compass. See Report of G. F. Dodwell, p. 153.

AUSTRALASIA.

AUSTRALIA—*Continued.*

Station	Latitude	Long. East of Gr.	Date	Declination		Inclination		Hor. Intensity		Instruments		Obs'r
				Local Mean Time	Value	L. M. T.	Value	L. M. T.	Value	Mag'r	Dip Circle	
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Mount Gason Bore	27 20.2 S	138 45	Jun 18, '14	14.9, 16.6	5 15.8 E	....	....	15.4, 16.2	.29342	9	....	ALK
			Jun 19, 14	....	....	10.3	57 58.0 S	....	....	......	41.5(12)	ALK
Patchawarra Well, 1	27 20.9 S	140 41	May 16, 14	14.5, 16.5	5 51.4 E	....	....	15.1, 16.0	.29336	9	....	ALK
Patchawarra Well, 2	27 20.9 S	140 41	May 20, 14	13.5, 16.0	5 52.6 E	....	....	14.7, 15.6	.29366	9	....	ALK
			May 21, 14	....	....	9.0, 10.2	57 50.5 S	....	....	......	41.5(12)	ALK
Cue	27 25.6 S	117 53	Aug 8, 14	10.2, 11.4	1 38.2 W	13.7	60 22.9 S	10.6, 11.2	.27257	14	14.1256	WCP
Brisbane	27 27.0 S	153 02	Mar 23, 14	14.5, 16.4	9 04.3 E	13.0	56 07.9 S	14.9, 15.8	.30146	17	172.25(78)	FB
Marble Well	27 33.1 S	134 00	Oct 16, 14	18.0	4 23.6 E	....	....	....	....	6	....	GFD
Stanley's Well	27 42.6 S	134 07	Oct 22, 14	....	....	18.0	58 44.5 S	....	....	......	38.12	GFD
			Oct 23, 14	12.4, 16.6	3 28.8 E	....	....	13.6, 15.8	.28870	6	....	GFD
Lake Miranda	27 43.2 S	120 33	May 27, 14	16.5	0 52.0 W	15.8	60 03.5 S	16.8	.27799	24	EI 24	EK
Mirra-Mitta Bore	27 43.7 S	138 44	Jun 21, 14	13.6, 15.5	5 06.0 E	10.3	58 26.0 S	14.3, 15.1	.29048	9	41.5(12)	ALK
Innamincka, 1	27 45.5 S	140 44	May 5, 14	13.3, 15.8	5 53.3 E	10.5	58 16.6 S	14.2, 15.3	.29180	9	41.(12)	ALK
			May 6, 14	....	....	8.0, 8.8	58 13.5 S	....	....	......	41.5(12)	ALK
Innamincka, 2	27 45.7 S	140 44	May 12, 14	14.4, 16.3	5 53.8 E	....	....	15.0, 15.8	.29194	9	....	ALK
Christlieb Well	27 57.2 S	134 46	Oct 27, 14	17.2	4 17.4 E	....	....	17.5, 17.9	.28700	6	....	GFD
Lawlers	28 05.2 S	120 30	May 25, 14	15.6, 16.8	0 19.8 W	14.5, 14.9	61 08.8 S	15.9, 16.5	.27185	24	EI 24	EK
Raspberry Creek Bore	28 08.2 S	135 05	Oct 30, 14	11.4, 14.6	3 43.6 E	17.2	59 26.0 S	12.2, 14.0	.28546	6	38.12	GFD
Nappacoongie Well	28 11.8 S	140 30	May 2, 14	14.8, 17.8	5 48.4 E	8.6, 10.8	58 47.0 S	15.3, 16.4	.28920	9	41.5(2)	ALK
Nilpinna	28 13.1 S	135 42	Nov 3, 14	14.4, 17.7	4 07.4 E	....	....	15.1, 17.0	.28391	6	....	GFD
			Nov 4, 14	....	....	11.9	59 47.6 S	....	....	......	38.12	GFD
Ooroowilanie Reservoir	28 17.0 S	138 40	Jun 24, 14	13.6, 15.4	5 08.5 E	10.2	59 03.6 S	14.0, 14.9	.28748	9	41.5(2)	ALK
Bunbenoo, *A*	28 17.0 S	115 54	Oct 14, 16	10.8, 12.7, 15.8	2 38.7 W	15.2	62 02.1 S	11.2, 12.3	.26202	18	201.(1234)	W&P
			Oct 16, 16	....	....	16.7	62 01.2 S	....	....	......	201.(12)	W&P
Bunbenoo, *B*	28 17.1 S	115 54	Oct 16, 16	12.4, 16.2	2 55.9 W	15.8	61 51.0 S	....	....	*201*	201.(12)	W&P
Bunbenoo, *C*	28 17.1 S	115 54	Oct 16, 16	13.0, 15.1	2 41.4 W	14.7	61 50.4 S	....	....	*201*	201.(12)	W&P
Tallering, *A*	28 19.9 S	115 49	Oct 11, 16	10.9, 12.6, 16.1	2 41.8 W	15.5	62 01.6 S	11.3, 12.3	.26258	18	201.(1234)	W&P
Tallering, *B*	28 20.0 S	115 49	Oct 12, 16	10.7, 12.7, 16.2	2 59.9 W	15.6	61 50.0 S	11.1, 12.4	.26342	18	201.(1234)	W&P
Tallering, *C*	28 20.0 S	115 49	Oct 13, 16	10.2, 12.1, 15.8	2 34.3 W	14.9	61 42.8 S	10.6, 11.2	.26378	18	201.(134)	W&P
Warren's Flat, *A*	28 20.0 S	115 47	Oct 17, 16	11.4, 13.3, 15.5	2 27.2 W	14.9	61 50.1 S	12.2, 13.0	.26432	18	201.(1234)	W&P
			Oct 18, 16	....	....	15.7	61 50.9 S	....	....	......	201.(12)	W&P
Warren's Flat, *B*	28 20.1 S	115 47	Oct 18, 16	11.4, 14.2	2 36.7 W	14.7	61 53.9 S	....	....	*201*	201.(12)	W&P
Warren's Flat, *C*	28 20.1 S	115 47	Oct 18, 16	11.9, 13.0	2 32.5 W	13.5	61 58.2 S	....	....	*201*	201.(12)	W&P
Tallering (Sand-plain), *A*	28 21.1 S	115 48	Oct 19, 16	11.2, 13.2, 15.6	2 36.9 W	15.0	61 46.4 S	12.3, 13.0	.26538	18	201.(1234)	W&P
			Oct 20, 16	....	....	14.3	61 45.4 S	....	....	......	201.(12)	W&P
Tallering (Sand-plain), *B*	28 21.2 S	115 48	Oct 20, 16	10.4, 13.1	2 23.4 W	13.5	62 08.1 S	....	....	*201*	201.(12)	W&P
Tallering (Sand-plain), *C*	28 21.2 S	115 48	Oct 20, 16	10.9, 12.2	2 06.4 W	12.6	61 43.5 S	....	....	*201*	201.(12)	W&P
Woondenooka, *A*	28 24.5 S	115 29	Oct 23, 16	11.2, 13.2	3 49.3 W	14.9	61 43.8 S	12.7	.26459	18	201.(12)	W&P
Woondenooka, *B*	28 24.6 S	115 29	Oct 23, 16	15.3	3 45.5 W	15.6	61 48.2 S	....	....	*201*	201.(12)	W&P
Woondenooka, *C*	28 24.6 S	115 29	Oct 23, 16	16.0	3 44.2 W	16.3	61 48.2 S	....	....	*201*	201.(12)	W&P
Pindar, *B*	28 28.2 S	115 45	Sep 15, 16	10.8, 16.0	3 07.4 W	13.9	61 50.1 S	11.2, 12.4	.26408	18	201.(1234)	W&P
Pindar, *D*	28 28.2 S	115 45	Sep 18, 16	9.5, 10.9, 14.0	3 12.8 W	12.7	61 51.2 S	9.9, 10.6	.26452	18	201.(1234)	W&P
			Sep 18, 16	16.0	3 09.8 W	....	....	....	....	18	....	W&P
Pindar, *A*	28 28.3 S	115 45	Sep 14, 16	9.9, 11.4, 16.2	3 07.4 W	12.9	61 49.8 S	10.3, 11.0	.26442	18	201.(1234)	W&P
Pindar, *C*	28 28.3 S	115 45	Sep 16, 16	8.9, 16.0	3 10.0 W	10.9	61 50.9 S	9.3, 10.0	.26450	18	201.(1234)	W&P
Pindar, *E*	28 29.6 S	115 48	Sep 19, 16	9.3, 10.8, 15.2	3 04.0 W	13.1	61 54.6 S	9.7, 10.4	.26272	18	201.(1234)	W&P
Pindar, *G*	28 29.6 S	115 48	Sep 21, 16	8.7, 10.3, 14.9	2 34.7 W	11.2	62 01.8 S	9.1, 9.9	.26232	18	201.(1234)	W&P
Pindar, *F*	28 29.7 S	115 48	Sep 20, 16	9.1, 11.1, 15.0	2 56.5 W	12.6	61 56.2 S	9.6, 10.5	.26242	18	201.(1234)	W&P
Mullewa, *A*	28 32.0 S	115 30	Oct 24, 16	8.9	3 29.5 W	9.3	62 00.5 S	....	....	*201*	201.(12)	W&P
Mullewa, *B*	28 32.1 S	115 30	Oct 24, 16	9.7	3 26.9 W	10.0	61 59.4 S	....	....	*201*	201.(12)	W&P
Mullewa, *C*	28 32.1 S	115 30	Oct 24, 16	10.6	3 31.2 W	11.1	62 04.8 S	....	....	*201*	201.(12)	W&P
Murta Murta Well	28 36.7 S	140 17	Apr 29, 14	14.4, 17.1	5 42.8 E	....	....	15.4, 16.7	.28667	9	....	ALK
			Apr 30, 14	....	....	8.9, 10.0	59 15.2 S	....	....	......	41.56(2)	ALK
Etadunna	28 43.1 S	138 38	Jun 27, 14	13.5, 15.4	5 23.2 E	10.5	59 28.9 S	14.0, 14.9	.28484	9	41.5(12)	ALK
Leonora	28 52.0 S	121 18	May 20, 14	11.8	0 30.0 W	10.4	61 32.9 S	12.1	.26811	24	EI 24	EK
Dromedary Hill	29 02.1 S	118 27	Aug 6, 14	8.7, 10.2	1 40.9 W	11.1	62 11.2 S	9.1, 9.9	.25961	14	14.1256	WCP
Carraweena	29 11.0 S	139 59	Apr 26, 14	15.0, 17.3	5 43.2 E	....	....	15.6, 16.8	.28336	9	....	ALK
			Apr 27, 14	....	....	8.9, 10.1	59 57.8 S	....	....	......	41.5(12)	ALK
Clayton Bore	29 16.8 S	138 23	Jun 30, 14	13.9, 16.0	5 16.8 E	10.6	60 02.7 S	14.6, 15.6	.28282	9	41.5(12)	ALK
Murnpeowie	29 35.3 S	139 03	Apr 19, 14	13.9, 16.1	5 31.3 E	9.4, 11.2	60 20.2 S	14.6, 15.6	.28048	9	41.5(12)	ALK
Mount Hopeless Bore	29 36.4 S	139 45	Apr 23, 14	14.5, 17.2	5 26.2 E	....	....	15.4, 16.6	.28050	9	....	ALK
			Apr 24, 14	....	....	9.4, 10.3	60 17.7 S	....	....	......	41.5(12)	ALK
Hergott Springs	29 39.4 S	138 03	Jul 5, 14	14.2, 15.8	5 11.5 E	10.9	60 33.2 S	14.7, 15.5	.27934	9	41.5(12)	ALK
Pinjarrega, *A*	30 02.4 S	115 57	Nov 14, 16	12.7, 14.1	4 03.4 W	16.3	63 23.7 S	13.1, 13.7	.25302	18	201.(1234)	W&P
Pinjarrega, *B*	30 02.5 S	115 57	Nov 15, 16	11.2, 12.7, 13.7	4 09.5 W	14.5	63 21.8 S	11.6, 12.4	.25356	18	201.(1234)	W&P
Pinjarrega, *C*	30 02.5 S	115 57	Nov 17, 16	12.9, 14.1	4 03.2 W	15.2	63 20.9 S	13.3, 13.8	.25321	18	201.(1234)	W&P
Farina, *A*	30 04.4 S	138 17	Apr 9, 14	10.2, 15.2	5 52.0 E	17.0	61 01.4 S	10.8, 14.6	.27632	9	41.(12)	ALK
			Apr 10, 14	....	....	10.1	61 01.5 S	....	....	......	41.5	ALK
Marchagee, *A*	30 05.1 S	115 56	Nov 9, 16	10.4, 12.6, 16.0	4 20.8 W	15.4	63 24.8 S	10.9, 12.3	.25317	18	201.(1234)	W&P
			Nov 10, 16	....	....	9.7	63 23.0 S	....	....	......	201.(12)	W&P
Marchagee, *D*	30 05.1 S	115 56	Nov 10, 16	12.9, 14.2	4 16.2 W	13.4	63 26.8 S	....	....	*201*	201.(12)	W&P
			Nov 11, 16	....	....	....	....	14.9, 15.5	.25326	18	....	W&P

AUSTRALASIA.

AUSTRALIA—*Continued.*

Station	Latitude	Long. East of Gr.	Date	Declination: Local Mean Time	Declination: Value	Inclination: L. M. T.	Inclination: Value	Hor. Intensity: L. M. T.	Hor. Intensity: Value	Instruments: Mag'r	Instruments: Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Marchagee, *B*	30 05.2 S	115 56	Nov 10, '16	10.5,15.2	4 16.0 W	11.0	63 23.4 S	....	....	*201*	201.(12)	W&P
			Nov 11, 16	....	....	....	....	9.6,10.2	.25330	18	....	W&P
Marchagee, *C*	30 05.2 S	115 56	Nov 10, 16	12.0,14.7	4 17.8 W	12.4	63 25.8 S	....	....	*201*	201.(12)	W&P
			Nov 11, 16	....	....	....	....	11.3,12.0	.25334	18	....	W&P
Mount Lyndhurst	30 11.0 S	138 42	Apr 15, 14	10.1,13.9	5 32.9 E	15.0,16.0	61 02.2 S	11.2,13.3	.27534	9	41.5(12)	ALK
Watheroo, *A*	30 17.8 S	116 03	Dec 20, 16	13.4,14.8	4 10.1 W	16.3	64 01.3 S	13.7,14.4	.25100	18	201.(1234)	W&P
Watheroo, Observatory Site, *G*	30 18.7 S	115 52.4	Oct 6, 17	....	....	10.0	63 44.9 S	....	....	......	EI 2	WFW
			Oct 8, 17	....	....	14.2	63 42.9 S	....	....	......	EI 2	WFW
Watheroo, Observatory Site, *B*	30 18.9 S	115 53	Feb 10, 17	11.2,12.6	4 23.8 W	13.2	63 43.2 S	11.6,12.2	.25052	18	201.(1234)	W&P
Watheroo, Observatory Site, *I*	30 18.9 S	115 52.6	Apr 9, 18	10.0,15.0	4 21.9 W	11.2,13.6	63 47.8 S	10.1,14.9	.24989	18	201.(1234)	WCP
Watheroo, Observatory Site, *C*	30 19.0 S	115 53	Feb 12, 17	10.9,12.8	4 21.7 W	13.5	63 42.2 S	11.4,11.9	.25082	18	201.(1234)	W&P
Watheroo, Observatory Site, *D*	30 19.0 S	115 53	Feb 13, 17	10.5,11.8	4 25.7 W	12.8	63 42.0 S	10.9,11.4	.25074	18	201.(1234]	W&P
Watheroo, Observatory Site, *H*	30 19.0 S	115 52.6	Apr 8, '18	10.0,15.6	4 23.5 W	11.4,13.6	63 48.5 S	9.9,15.1	.24987	18	201.(1234)	WCP
Watheroo, Observatory Site, *F*[1]	30 18.7 S	115 52.4	*1917* Jul 31	10.1,15.0	4 22.8 W	13.4	63 44.6 S	10.2,15.0	.25054	18	201.(1234)	WCP
			Aug 1	8.1 to 17.1 (dv)	4 23.0 W	....	....	....	....	18	....	WCP
			Aug 21	9.6,14.9	4 20.7 W	13.3	63 49.0 S	9.6,14.9	.25006	18	201.(1234)	WCP
			Sep 1	7.7 to 17.8 (dv)	4 22.2 W	....	....	....	....	18	....	WCP
			Sep 3,21	9.4,14.9	4 22.5 W	13.3	63 45.8 S	9.4,14.9	.25027	18	201.(1234)	WCP
			Sep 29	8.6,13.7	4 22.2 W	10.2	63 43.8 S	8.6,13.7	.25068	18	201.(1234)	WCP
			Oct 2	7.5 to 17.2 (dv)	4 22.2 W	....	....	....	....	18	....	WCP
			Oct 5,13, 27	{7.8, 9.2 / 13.0,14.3}	4 22.1 W	10.1	63 45.4 S	8.5,13.7	.25035	18	201.(1234)	WCP
			Oct 6	....	....	14.9	63 44.9 S	....	....	......	EI 2	WFW
			Oct 8	....	....	9.3	63 44.1 S	....	....	......	EI 2	WFW
			Oct 19	10.0,14.6	4 22.9 W	13.5	63 43.3 S	10.0,14.6	.25047	18	201.(1234)	WCP
			Nov 1	7.2 to 16.9 (dv)	4 21.6 W	....	....	....	....	18	....	WCP
			Nov 2, 8, 17	{8.1, 9.4 / 13.5,14.6}	4 22.6 W	10.2	63 44.9 S	8.7,14.0	.25039	18	201.(1234)	WCP
			Dec 4	9.1,13.6	4 21.4 W	10.5	63 44.9 S	9.1,13.6	.25056	18	201.(1234)	WCP
			Dec 17,29	9.5,14.8	4 23.8 W	14.2	63 46.0 S	9.5	.24969	18	201.(1234)	WCP
			1918 Jan 1	7.1 to 17.3 (dv)	4 22.4 W	....	....	....	....	18	....	WCP
			Jan 5,14, 21,28	8.6, 9.8,13.7	4 23.3 W	14.5	63 44.9 S	9.2	.25036	18	201.(1234)	WCP
			Feb 4	7.3 to 18.0 (dv)	4 20.8 W	....	....	....	....	18	....	WCP
			Feb 7,14	8.2, 9.5,14.3	4 23.8 W	14.0	63 47.2 S	8.9	.25010	18	201.(1234)	WCP
			Mar 5	7.5 to 17.7 (dv)	4 21.9 W	....	....	....	....	18	....	WCP
			Mar 7,13, 19,25	8.3, 9.7,14.7	4 21.2 W	14.1	63 46.3 S	9.0	.25018	18	201.(1234)	WCP
			Apr 1	8.0 to 17.7 (dv)	4 19.6 W	....	....	....	....	18	....	WCP
			Apr 10	9.6,14.4	4 21.0 W	10.8,13.2	63 48.1 S	9.6,14.4	.25000	18	201.(1234)	WCP
			Apr 16	8.5, 9.7,14.0	4 24.0 W	13.4	63 46.4 S	9.1	.25002	18	201.(1234)	WCP
			May 4	7.8 to 17.0 (dv)	4 21.7 W	....	....	....	....	18	....	WCP
			May 11,16, 25,30	8.7, 9.9,14.7	4 22.3 W	14.2	63 48.1 S	9.4	.25006	18	201.(1234)	WCP
			Jun 1	8.0 to 14.8 (dv)	4 21.8 W	....	....	....	....	18	....	WCP
Watheroo Observatory, N_m[1]	30 18.9 S	115 52.6	Jun 6	9.2	4 24.4 W	....	....	....	....	18	....	WCP
			Jun 8	9.0,10.4	4 25.3 W	....	....	9.7	.25015	18	....	WCP
			Jun 9	2.6 to 8.8 (dv)	4 21.9 W	....	....	....	....	18	....	WCP
			Jun 13	....	....	9.8	63 51.2 S	....	....	......	201.(1234)	WCP
			Jun 20,26	9.5,11.0,14.8	4 24.8 W	13.5	63 47.9 S	10.3	.25006	18	201.(1234)	WCP
			Jul 3	7.9 to 17.0 (dv)	4 25.7 W	....	....	....	....	18	....	WCP
			Jul 4,13, 18,25, 31	9.0,10.4,14.5	4 24.3 W	13.9	63 49.2 S	9.8	.25001	18	201.(1234)	WCP
			Aug 1	7.6 to 17.3 (dv)	4 23.8 W	....	....	....	....	18	....	WCP
			Aug 6,14, 21,28	8.8,10.3,14.3	4 24.4 W	13.6	63 49.7 S	9.6	.24987	18	201.(1234)	WCP
			Sep 2	7.8 to 17.3 (dv)	4 24.8 W	....	....	....	....	18	....	WCP
			Sep 4,10, 17,23, 30	9.0,10.4,14.8	4 23.7 W	13.5	63 50.4 S	9.7	.24962	18	201.(1234)	WCP
			Oct 1	7.7 to 17.1 (dv)	4 23.8 W	....	....	....	....	18	....	WCP

[1] Where several days are grouped in the date column with but single entries of magnetic elements the values are the means of determination made at the given local mean times on each day.

AUSTRALASIA.

AUSTRALIA—*Continued.*

Station	Latitude	Long. East of Gr.	Date	Declination		Inclination		Hor. Intensity		Instruments		Obs'r
				Local Mean Time	Value	L. M. T.	Value	L. M. T.	Value	Mag'r	Dip Circle	
	° ′	° ′	*1918*	h h h	° ′	h h	° ′	h h	c. g. s.			
Watheroo Observatory, N_m —*Concluded*...........	30 18.9 S	115 52.6	Oct 19,26, 31	8.6,10.2,15.8	4 24.8 W	13.7	63 50.2 S	9.5	.24973	18	201.(1234)	WCP
			Nov 1	7.7 to 17.2 (dv)	4 23.5 W	....	....	....	....	18	....	WCP
			Nov 6,12, 19,25	8.4, 9.9,15.6	4 24.7 W	13.6	63 50.1 S	9.1	.24963	18	201.(1234)[1]	WCP
			Dec 2	7.9 to 17.2 (dv)	4 24.6 W	....	....	....	....	18	....	WCP
			Dec 3	8.0, 9.6,15.7	4 24.3 W	13.4	63 50.5 S	8.8	.24954	18	201.(124)	WCP
			1919									
Watheroo Observatory[2]...	30 18.9 S	115 52.6	Jan 1, 7, 14,21, 28	9.0,11.0,15.1	4 22.9 W	14.2,15.2	63 49.4 S	9.5,10.6	.24958	7	EI 2	WCP
			Feb 4,11, 18	8.9,10.7,14.0	4 24.9 W	13.6,14.4	63 49.4 S	9.3,10.3	.24936	7	EI 2	WCP
			Mar 8,11, 18,25	8.7,10.6,13.7	4 25.3 W	13.4,14.1	63 49.8 S	9.2,10.2	.24925	7	EI 2	WCP
			Apr 1, 8, 15,23, 29	9.0,10.9,14.0	4 23.0 W	13.6,14.2	63 50.8 S	9.5,10.5	.24926	7	EI 2	WCP
			Apr 16	....	....	....	....	9.4,10.2	.24958	7	....	WCP
			May 3,10, 13,20, 27	8.3,10.3,14.0	4 23.3 W	13.7,14.3	63 54.0 S[3]	8.8, 9.9	.24917	7	EI 2	WCP
			May 29	17.1 to 24.4 (dv)	4 22.9 W	....	....	....	....	7	....	WCP
			Jun 3,10, 17,24	8.0,10.0,14.0	4 22.8 W	13.7,14.2	63 51.9 S	8.5, 9.6	.24940	7	EI 2	WCP
			Jun 11	....	....	....	....	8.6, 9.3	.24915	7	....	WCP
			Jun 18	....	....	7.9, 8.3	63 50.4 S	....	....	......	EI 2	WCP
			Jul 1, 8, 15,22, 29	8.2,10.2,13.9	4 23.2 W	13.6,14.2	63 51.0 S	8.8, 9.8	.24941	7	EI 2	WCP
			Jul 2	....	....	....	....	8.6, 9.6	.24977	7	....	WCP
			Aug 5,12, 14,19, 26	9.1,10.9,14.2	4 24.0 W	13.8,14.3	63 53.0 S	9.7,10.6	.24908	7	EI 2	WCP
			Sep 2, 9, 16,23, 30	8.8,10.8	4 26.6 W	14.0,14.6	63 52.3 S	9.3,10.4	.24909	7	EI 2	WCP
			Oct 7,14, 21,28	9.4,11.9[4]....	4 25.2 W	14.7,15.4	63 52.5 S	9.9,11.5	.24916	7	EI 2	W&P
			Nov 4,11, 18,25	9.1,11.0	4 25.7 W	13.8,14.2	63 52.0 S	9.5,10.6	.24938	7	EI 2	K&P
			Dec 2, 9, 16,23, 30	9.0,10.9	4 25.9 W	13.6,14.0	63 52.6 S	9.4,10.4	.24909	7	EI 2	K&P
			1920									
			Jan 6,13, 20,27	8.9,10.8	4 24.3 W	13.9,14.3	63 51.7 S	9.5,10.4	.24928	7	EI 2	K&P
			Feb 3,10, 17,24	9.0,10.9	4 25.0 W	13.3,13.6	63 52.2 S	9.6,10.5	.24918	7	EI 2	K&P
			Mar 2, 9, 16,30	8.8,10.5	4 25.7 W	14.2,14.5	63 54.2 S	9.3,10.2	.24892	7	EI 2	K&P
			Mar 24[5]	8.1,10.1	4 25.7 W	10.6,11.0	64 03.2 S	8.6, 9.7	.24762	7	EI 2	K&P
			Apr 6,13, 20,27	8.3,10.5	4 24.9 W	....	....	9.2,10.1	.24882	7	....	K&P
			Apr 6,27	....	....	13.1,13.4	63 54.6 S	....	....	......	EI 2	K&P
			Apr 13,20	....	....	8.2, 8.5	63 55.3 S	....	....	......	EI 2	K&P
			May 4,11, 18,25	8.9,10.8	4 22.9 W	13.3,13.7[6]	63 54.9 S	9.6,10.4	.24898	7	EI 2	K&P
			Jun 1, 8, 15,22, 29	8.6,11.4[7]....	4 22.7 W	11.1,11.4[8]	63 53.9 S	9.4,10.4	.24904	7	EI 2	K&P
			Jul 1	9.8,13.1	4 22.0 W	....	....	10.3,11.1	.24902	7	....	WCP
			Jul 6,13, 20,27	9.6,11.0[9]....	4 22.9 W	8.6, 8.9	63 54.2 S	10.0,11.2	.24895	7	EI 2	WCP
			Jul 19	13.2,13.6	4 22.2 W	....	....	....	....	7	....	WCP

[1] Needle 201.(3) not used after November 6.

[2] On January 1, 1919, the regular observations for the control of the magnetograph were begun; the declination and horizontal-intensity values were thereafter determined at station N_m and the inclination values at station N_w. See also foot-note 1, p. 57.

[3] This includes unusually high value, 63° 58′.0 S, observed on May 3.

[4] The second observation on October 21 was at $13^h.9$ instead of at $11^h.9$.

[5] Magnetic storm.

[6] On May 4 the times of observations were $7^h.9$ and $8^h.2$.

[7] The second observation on June 15 was at $14^h.6$ instead of at $11^h.4$.

[8] The observations on June 15 were at $8^h.2$ and $8^h.5$ instead of at $11^h.1$ and $11^h.4$.

[9] The second observation on July 6 was at $14^h.0$ instead of at $11^h.0$.

AUSTRALASIA.

AUSTRALIA—*Continued.*

Station	Latitude	Long. East of Gr.	Date	Declination		Inclination		Hor. Intensity		Instruments		Obs'r
				Local Mean Time	Value	L. M. T.	Value	L. M. T.	Value	Mag'r	Dip Circle	
	° ′	° ′	*1920*	*h h h*	° ′	*h h*	° ′	*h h*	*c. g. s.*			
Watheroo Observatory[1]—*Concluded*	30 18.9 S	115 52.6	Aug 3,10, 17,24, 31	9.2,10.9[2]	4 23.3 W	8.2, 8.6	63 54.5 S	9.7,10.6	.24892	7	EI 2	K&P
			Sep 7,14, 21,28	9.1,10.8	4 25.2 W	8.5, 8.8	63 54.8 S[3]	9.5,10.5	.24900	7	EI 2	K&P
			Sep 13	8.9,10.7	4 26.2 W	....	....	9.4,10.3	.24884	7	....	WCP
			Sep 13	13.3,15.3	4 20.0 W	....	....	13.8,14.9	.24874	7	....	EK
			Sep 14	13.1,14.7	4 20.4 W	....	....	13.5,14.3	.24866	5	....	C VI
			Sep 15	8.6,10.5	4 23.5 W	....	....	9.1,10.0	.24906	5	....	C VI
			Sep 15	12.9,14.6	4 20.2 W	....	....	13.3,14.2	.24880	5	....	C VI
			Sep 15	....	....	....	....	15.2	.24859	7	....	WCP
			Sep 16	....	....	8.8 to 11.4	63 55.7 S	....	....	......	EI 2	EK
			Sep 16	....	....	13.0 to 15.1	63 55.8 S	....	....	......	EI 7	C VI
			Oct 5,12, 19,26	9.2,10.9[4]	4 24.8 W	8.4, 8.7	63 56.4 S	9.7,10.5	.24873	7	EI 2	K&P
			Nov 2, 9, 16,23, 30	9.1,10.7	4 25.7 W	8.4, 8.7	63 55.7 S	9.5,10.4	.24886	7	EI 2	K&P
			Dec 7,14, 21,28	9.0,10.6	4 25.7 W	8.3, 8.6	63 55.7 S	9.5,10.3	.24875	7	EI 2	K&P
			1920									
Watheroo Observatory, S_m.	30 18.9 S	115 52.6	Jul 14	13.5,15.1	4 21.6 W	....	....	14.0,14.8	.24880	7	....	WCP
			Jul 15,17	9.4,10.9	4 23.8 W	....	....	9.8,10.5	.24897	7	....	WCP
			Sep 13	8.9,10.7	4 26.5 W	....	....	9.4,10.3	.24885	5	....	C VI
			Sep 13	13.3,15.3	4 19.8 W	....	....	13.8,14.9	.24881	5	....	C VI
			Sep 14	8.5,10.8	4 25.8 W	....	....	9.1,10.3	.24886	5	....	C VI
			Sep 14	13.1,14.7	4 21.1 W	....	....	13.5,14.3	.24874	7	....	WCP
			Sep 15	8.6,10.5	4 24.1 W	....	....	9.1,10.0	.24898	7	....	EK
			Sep 15	12.9,14.6	4 20.5 W	....	....	13.3,14.2	.24868	7	....	WCP
			Sep 15	....	....	....	....	15.2	.24875	5	....	C VI
Watheroo Observatory, S_w.	30 18.9 S	115 52.6	Sep 16	....	....	8.8 to 11.4	63 56.0 S	....	....	......	EI 7	C VI
			Sep 16	....	....	13.0 to 15.1	63 56.1 S	....	....	......	EI 2	WCP
Managum Well, *A*	30 20.6 S	115 58	Feb 5, '17	9.2,10.8,15.5	4 57.7 W	14.7	63 49.7 S	9.7,10.5	.24098	18	201.(1234)	W&P
			Feb 9, 17	....	....	10.3	63 53.8 S	....	....	......	201.(1234)	W&P
Managum Well, *B*	30 20.6 S	115 58	Feb 9, 17	11.7,15.3	4 51.2 W	12.2	63 52.2 S	....	....	*201*	201.(1234)	W&P
Managum Well, *C*	30 20.6 S	115 58	Feb 9, 17	12.9,14.7	5 06.3 W	13.4	63 52.5 S	....	....	*201*	201.(1234)	W&P
Rabbit-Proof Fence 3	30 23.4 S	118 32	Aug 4, 14	13.6,15.0	2 34.6 W	16.5	63 21.4 S	14.0,14.7	.25528	14	14.1256	WCP
Carnding Well	30 27.4 S	134 13	Sep 12, 14	13.9,16.0	4 07.6 E	....	....	14.4,15.5	.26680	9	....	ALK
			Sep 13, 14	....	....	10.2	62 10.8 S	....	....	......	177.1256	ALK
Ooldea Bore	30 27.9 S	131 50	Sep 23, 14	14.4,16.3	3 07.2 E	....	....	14.9,15.9	.26782	9	....	ALK
			Sep 24, 14	....	....	8.8	62 16.6 S	....	....	......	177.1256	ALK
Yallalie Well	30 28.2 S	115 47	Jan 27, 17	8.8,10.2,16.4	4 11.8 W	11.3	63 53.8 S	9.2, 9.9	.24928	18	201.(1234)	W&P
Bore *A*	30 30.2 S	131 25	Sep 25, 14	8.1,10.0	2 56.0 E	6.7	62 04.9 S	8.6, 9.6	.26874	9	177.1256	ALK
Green's Well	30 31.5 S	115 44	Jan 25, 17	9.5,11.0,15.4	4 06.5 W	14.6	63 55.0 S	9.9,10.6	.24886	18	201.(1234)	W&P
Bench-Mark 56½	30 32.8 S	132 46	Sep 19, 14	8.0, 9.8	3 00.4 E	6.6	61 44.6 S	8.5, 9.4	.27210	9	177.1256	ALK
Wynbring Rock-Hole	30 33.7 S	133 39	Sep 16, 14	13.5,15.6	3 45.8 E	9.6	63 04.7 S	14.2,15.1	.26448	9	177.1256	ALK
Bore *B*	30 34.1 S	130 55	Sep 26, 14	9.6,11.6	2 27.0 E	7.4	62 11.8 S	10.4,11.3	.26850	9	177.1256	ALK
Karamara, *4N*	30 37.9 S	115 52	Jul 14, 16	....	....	13.3	63 57.7 S	....	....	......	201.(1)	P&R
Karamara, *6N*	30 37.9 S	115 52	Jul 14, 16	....	....	12.2	63 58.6 S	....	....	......	201.(1)	P&R
Moora	30 38.0 S	115 59	Jul 22, 14	14.1,15.4	4 40.9 W	12.9	63 52.8 S	14.5,15.1	.25016	14	14.12	WCP
Karamara, *A*	30 38.0 S	115 52	Jul 14, 16	....	....	....	....	16.4	.24875	18	....	P&R
Karamara, *2N*	30 38.0 S	115 52	Jul 14, 16	....	....	14.0	63 58.9 S	....	....	......	201.(1)	P&R
Karamara, *2S*	30 38.0 S	115 52	Jul 14, 16	....	....	14.6	63 57.7 S	....	....	......	201.(1)	P&R
Karamara, *4S*	30 38.1 S	115 52	Jul 14, 16	....	....	15.3	63 59.7 S	....	....	......	201.(1)	P&R
Karamara, *6S*	30 38.1 S	115 52	Jul 14, 16	....	....	15.9	63 58.5 S	....	....	......	201.(1)	P&R
Tarcoola	30 41.8 S	134 34	Sep 8, 14	13.9,16.0	4 04.8 E	12.0	62 09.4 S	14.4,15.5	.26544	9	177.1256	ALK
Gilbert's Well	30 51.4 S	135 06	Sep 5, 14	....	....	16.9	62 08.8 S	....	....	......	177.1256	ALK
			Sep 6. 14	7.8,10.0	3 36.2 E	10.8	62 09.5 S	8.4, 9.6	.26796	9	177.15	ALK
Wongan Hills, *A*	30 53.6 S	116 43	Jul 29, 16	11.2,12.6	3 40.0 W	13.9	64 12.8 S	11.5,12.3	.24908	18	201.(12)	WCP
			Sep 9, 16	10.4,15.1,16.2	3 37.8 W	12.9	64 14.4 S	10.8,11.5	.24881	18	201.(1234)	W&P
Wongan Hills, *A*, *Secondary*	30 53.6 S	116 43	Jul 29, 16	13.0	3 35.7 W	....	....	....	....	18	....	WCP
Wongan Hills, *B*	30 53.6 S	116 43	Sep 10, 16	10.0,13.8,16.7	1 50.1 W	12.8	64 07.0 S	10.4,11.1	.24897	18	201.(1234)	W&P
Wongan Hills, *C*	30 53.6 S	116 43	Sep 11, 16	9.6,11.0,14.8	3 36.6 W	12.5	64 06.4 S	10.0,10.6	.24990	18	201.(1234)	W&P
			Sep 11, 16	16.0	3 31.9 W	....	....	....	....	18	....	W&P
Coolgardie	30 57.2 S	121 11	May 9, 14	14.2,15.4	1 33.6 W	13.4	63 32.5 S	14.5,15.2	.25522	24	EI 24	EK

[1] See foot-note 2, p. 58, and foot-note 1, p. 57.

[2] The second observation on August 3 was at $14^h.4$ instead of at $10^h.9$.

[3] There were no inclination observations on September 14.

[4] The second observation on October 19 was at $14^h.0$ instead of at $10^h.9$.

AUSTRALASIA.

AUSTRALIA—*Continued.*

Station	Latitude	Long. East of Gr.	Date	Declination		Inclination		Hor. Intensity		Instruments		Obs'r
				Local Mean Time	Value	L. M. T.	Value	L. M. T.	Value	Mag'r	Dip Circle	
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
McArthur's Well	31 01.4 S	135 43	Sep 3, '14	13.7,15.8	4 15.5 E	16.8	62 30.9 S	14.3,15.3	.26732	9	177.1256	ALK
Nealyon's Rock-Hole	31 07.0 S	131 17	Oct 1, 14	9.5,11.4	3 15.0 E	7.9	62 50.0 S	10.0,11.1	.26353	9	177.1256	ALK
Wirraminna	31 10.9 S	136 16	Sep 1, 14	13.4,15.0	4 20.7 E	10.0	62 40.6 S	13.9,14.7	.26560	9	177.1256	ALK
East-West Railway Siding	31 16 S	136 47	Aug 27, 14	16.4	4 28.1 E	....	....	16.9	.26729	9	....	ALK
			Aug 28, 14	13.9,15.8	4 27.6 E	10.5	62 31.2 S	14.4,15.3	.26716	9	177.1256	ALK
Burracoppin, *D**	31 21.0 S	118 33	Aug 31, 16	11.1,16.3	2 05.2 W	15.3	64 25.1 S	12.7,13.7	.24850	18	201.(1234)	WCP
Burracoppin, *B**	31 21.1 S	118 33	Aug 29, 16	12.6,16.9	2 21.0 W	16.1	64 49.3 S	13.0,13.9	.24483	18	201.(1234)	W&P
Burracoppin, *C**	31 21.2 S	118 33	Aug 30, 16	12.6,16.3	2 36.4 W	15.4	64 43.2 S	13.0,13.8	.24447	18	201.(1234)	W&P
Burracoppin, *A**	31 24.4 S	118 31	Aug 26, 16	10.6,13.0,16.0	2 00.2 W	14.7	64 24.7 S	11.0,12.7	.24876	18	201.(1234)	W&P
Mallabie Tanks	31 27.8 S	130 39	Oct 4, 14	15.4,17.3	2 04.2 E	....	....	15.9,16.9	.25917	9	....	ALK
			Oct 5, 14	....	....	6.6	63 38.1 S	....	....	......	177.1256	ALK
Yangoonabie	31 28.5 S	130 05	Oct 6, 14	13.6,15.4	2 02.8 E	17.1	63 46.8 S	14.1,15.0	.25826	9	177.1256	ALK
Merredin, *A**	31 28.6 S	118 17	Sep 2, 16	10.4,16.1	3 28.2 W	13.2	64 32.6 S	10.9,15.7	.24810	18	201.(1234)	W&P
Merredin, *B**	31 28.6 S	118 17	Sep 4, 16	10.3,16.1	3 05.4 W	15.2	64 58.0 S	10.7,11.4	.24448	18	201.(1234)	W&P
Bunabie	31 31.2 S	129 22	Oct 8, 14	15.1	1 48.7 E	....	....	15.6,16.7	.26018	9	....	ALK
			Oct 9, 14	....	....	11.1	63 17.7 S	....	....	......	177.12	ALK
Rabbit-Proof Fence 2	31 39.0 S	118 42	Aug 2, 14	13.5,14.8	2 56.2 W	16.5	64 58.5 S	13.9,14.5	.24640	14	14.1256	WCP
Eucla	31 43.3 S	128 53	Jun 12, 14	10.6,12.1	1 43.7 E	14.2	63 37.6 S	11.0,11.8	.25832	14	14.1256	WCP
			Jun 14, 14	10.6,12.3	1 41.4 E	....	....	11.3,12.0	.25840	14	....	WCP
			Jun 14, 14	13.1 to 22.1 (dv)	1 39.6 E	....	....	....	....	14	....	WCP
			Oct 31, 14	13.9,16.0	1 48.6 E	11.0	63 35.2 S	14.5,15.6	.25836	9	177.1256	ALK
Madura	31 54.2 S	127 02	Jun 17, 14	10.2,11.8....	2 01.0 E	15.2	64 00.6 S	10.8,11.5	.25410	14	14.1256	WCP
Bookooloo	31 54.2 S	137 22	Aug 23, 14	13.7	4 45.8 E	10.5	63 18.4 S	14.4	.26101	9	177.1256	ALK
Perth	31 58.0 S	115 50	Apr 6, 14	10.8,13.3	4 43.0 W	14.5	65 06.8 S	....	....	14	14.1256	WCP
			Apr 8, 14	....	....	....	....	9.5,10.3	.24244	14	....	WCP
			Apr 13, 14	13.9,15.4	4 41.6 W	12.8,13.1	65 03.1 S	14.3,15.0	.24239	24	EI 24	EK
			Jul 17, 14	15.0 to								
			Jul 18, 14	14.7 (dv)	4 42.7 W	....	....	....	....	14	....	WCP
			Jun 13, 16	14.6,16.0	4 41.8 W	....	....	14.9,15.7	.24152	18	....	WCP
			Jun 15, 16	9.1 to 14.6 (dv)	4 45.1 W	....	....	....	....	18	....	WCP
Cottesloe, *A*	31 59.3 S	115 44	Nov 18, 14	11.0,14.1	4 43.4 W	....	....	11.9,13.0	.24229	24	....	EK
			Nov 18, 14	14.8,16.4	4 43.1 W	....	....	15.3,16.0	.24235	24	....	EK
			Nov 19, 14	9.8,11.6	4 45.6 W	....	....	10.4,11.2	.24232	14	....	EK
			Nov 19, 14	12.1,12.4	4 43.1 W	....	....	15.1,15.9	.24227	14	....	EK
			Nov 19, 14	14.4,16.4,16.7	4 42.6 W	....	....	....	....	14	....	EK
			Nov 20, 14	9.6,11.6	4 46.9 W	....	....	10.3,11.2	.24230	17	....	EK
			Nov 20, 14	12.1,14.5	4 42.6 W	....	....	12.5,14.2	.24224	17	....	EK
			Nov 25, 14	10.4 to 11.9	4 46.4 W	15.6,15.9	65 04.8 S	....	....	14	EI 24	K&K
			Nov 25, 14	12.8 to 14.6	4 40.8 W	....	....	....	....	17	....	ALK
			Nov 26, 14	....	....	9.6,10.2	65 03.2 S	....	....	......	EI 24	EK
			Nov 26, 14	....	....	11.7,13.4	65 03.2 S	....	....	......	177.1256	EK
			Dec 1, 14	....	....	10.2,11.8	65 03.6 S	....	....	......	177.1256	FB
			Dec 1, 14	....	....	15.1,17.3	65 03.9 S	....	....	......	14.1256	FB
			Dec 2, 14	....	....	10.0,11.6	65 03.6 S	....	....	......	172.25(78)	FB
			Dec 2, 14	....	....	15.0,16.8	65 04.3 S	....	....	......	177.1256	FB
			Dec 4, 14	....	....	10.0,11.9	65 03.2 S	....	....	......	172.25(78)	FB
			Dec 4, 14	....	....	14.7	65 03.8 S	....	....	......	177.1256	FB
			Dec 5, 14	....	....	10.2,11.8	65 03.0 S	....	....	......	177.1256	FB
			Jun 30, 16	14.2,15.9	4 44.0 W	....	....	14.7,15.6	.24138	18	....	WCP
			Jul 1, 16	7.1 to 17.4 (dv)	4 42.2 W	....	....	....	....	18	....	WCP
			Jul 6, 16	....	....	15.2	65 11.1 S	....	....	......	201.(1234)	WCP
			Aug 16, 16	7.1 to 17.4 (dv)	4 45.6 W	....	....	....	....	18	....	WCP
			Oct 2, 16	7.0 to 17.8 (dv)	4 48.4 W	....	....	....	....	18	....	WCP
			Nov 16, 16	8.7 to 17.7 (dv)	4 46.5 W	....	....	....	....	18	....	WCP
			Sep 7, 20	16.7	4 44.8 W	....	....	9.9,16.1	.23934	25	....	C VI
			Sep 8, 20	....	....	....	....	16.2	.23919	25	....	C VI
			Sep 9, 20	9.3,10.4,10.6	4 49.2 W	....	....	9.8	.23921	25	....	C VI
			Sep 9, 20	11.0,13.0	4 47.5 W	....	....	11.9,12.6	.23900	25	....	C VI
			Sep 9, 20	13.9	4 48.7 W	....	....	14.7,15.4	.23862	5	....	C VI
			Sep 10, 20	9.1,11.7,12.9	4 49.2 W	....	....	9.5,10.4	.23914	5	....	C VI
			Sep 10, 20	14.3,14.4	4 47.6 W	....	....	13.2,13.9	.23881	5	....	C VI
			Sep 13, 20	....	....	10.4 to 12.7 (6)	65 21.8 S	....	....	......	EI 25	C VI
			Sep 13, 20	....	....	14.2 to 15.7 (6)	65 22.6 S	....	....	......	EI 7	C VI
			Sep 21, 20	6.7 to 8.5 (dv)	4 50.4 W	....	....	....	....	25	....	C VI
			Sep 23, 20	16.0 to 17.7 (dv)	4 47.0 W	....	....	14.3,15.4	.23902	25	....	C VI
			Sep 28, 20	16.6 to 17.4 (dv)	4 44.2 W	....	....	....	....	25	....	C VI
			Sep 29, 20	5.9 to 7.9 (dv)	4 44.2 W	....	....	....	....	25	....	C VI
Cottesloe, *B*	31 59.3 S	115 44	Nov 18, 14	11.0,14.1	4 43.2 W	....	....	11.9,13.0	.24239	14	....	WCP
			Nov 18, 14	14.8,16.5	4 42.6 W	....	....	15.3,16.0	.24228	14	....	WCP

* Local disturbance.

AUSTRALASIA.

AUSTRALIA—*Continued.*

Station	Latitude	Long. East of Gr.	Date	Declination		Inclination		Hor. Intensity		Instruments		Obs'r
				Local Mean Time	Value	L. M. T.	Value	L. M. T.	Value	Mag'r	Dip Circle	
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Cottesloe, *B*.—*Concluded*..	31 59.3 S	115 44	Nov 19, '14	....	....	....	....	10.4,11.2	.24223	17	....	WCP
			Nov 19, 14	....	....	....	....	15.1,15.9	.24233	17	....	WCP
			Nov 20, 14	9.6,11.6	4 44.4 W	....	....	10.3,11.2	.24227	24	....	WCP
			Nov 20, 14	12.1,14.5	4 37.8 W	....	....	12.5,14.2	.24219	24	....	WCP
			Nov 21, 14	10.8,14.4	4 42.8 W	....	....	12.4,13.9	.24228	24	....	WCP
			Nov 21, 14	14.8,16.6	4 41.0 W	....	....	15.5,16.1	.24224	24	....	WCP
			Nov 23, 14	9.8,12.1	4 45.7 W	....	....	10.8,11.6	.24216	24	....	WCP
			Nov 23, 14	14.0,16.2	4 40.7 W	....	....	14.6,15.5	.24242	9	....	WCP
			Nov 24, 14	9.8,12.2	4 44.3 W	....	....	10.6,11.6	.24222	9	....	WCP
			Nov 24, 14	12.6,15.7	4 41.4 W	....	....	14.3,15.2	.24232	9	....	WCP
			Nov 25, 14	10.4 to 11.9(4)	4 46.1 W	15.8	65 03.7 S	....	....	17	177.1256	P&K
			Nov 25, 14	12.8 to 14.5(4)	4 41.0 W	....	....	....	....	24	....	WCP
			Nov 26, 14	....	....	9.9	65 02.9 S	....	....	......	177.1256	ALK
			Nov 26, 14	....	....	11.3-13.9(4)	65 03.6 S	....	....	......	EI 24	ALK
			Dec 1, 14	....	....	10.2,11.8	65 03.2 S	....	....	......	14.1256	WCP
			Dec 1, 14	....	....	15.0,17.3	65 04.1 S	....	....	......	177.1256	WCP
			Dec 2, 14	....	....	10.0,11.6	65 02.9 S	....	....	......	177.1256	WCP
			Dec 2, 14	....	....	15.0,16.8	65 03.6 S	....	....	......	172.25(78)	WCP
			Dec 4, 14	....	....	10.0,11.9	65 03.0 S	....	....	......	177.1256	WCP
			Dec 4, 14	....	....	14.8	65 04.2 S	....	....	......	172.25(78)	WCP
			Dec 5, 14	....	....	10.2,11.8	65 02.7 S	....	....	......	172.25(78)	WCP
			Sep 7, 20	16.7	4 46.4 W	....	....	10.0,16.1	.23926	5	....	C VI
			Sep 8, 20	....	....	....	....	16.2	.23921	5	....	C VI
			Sep 9, 20	9.3,10.4,10.6	4 50.5 W	....	....	9.8	.23923	5	....	C VI
			Sep 9, 20	11.0,13.0	4 48.4 W	....	....	11.9,12.6	.23900	5	....	C VI
			Sep 9, 20	13.9	4 49.9 W	....	....	14.7,15.3	.23862	25	....	C VI
			Sep 10, 20	9.1,11.7,12.9	4 50.8 W	....	....	9.5,10.4	.23906	25	....	C VI
			Sep 10, 20	14.3,14.4	4 49.6 W	....	....	13.2,13.9	.23874	25	....	C VI
			Sep 13, 20	....	....	10.4 to 12.7 (6)	65 23.3 S	....	....	......	EI 7	C VI
			Sep 13, 20	....	....	14.2 to 15.8(6)	65 23.0 S	....	....	......	EI 25	C VI
			Sep 14, 20	....	....	8.8 to 14.2(7)	65 22.9 S	10.0,11.5	.23918	25	EI 25	C VI
			Sep 14, 20	....	....	....	....	13.6	.23892	25	....	C VI
			Sep 16, 20	....	....	....	....	9.8,10.5	.23927	25	....	C VI
			Sep 16, 20	....	....	....	....	12.0,13.2	.23899	25	....	C VI
			Sep 16, 20	....	....	....	....	14.0,14.8	.23900	25	....	C VI
			Sep 16, 20	....	....	....	....	15.5	.23897	25	....	C VI
			Sep 17, 20	....	....	....	....	9.1, 9.7	.23916	25	....	C VI
			Sep 17, 20	....	....	....	....	10.2,10.7	.23936	25	....	C VI
			Sep 17, 20	....	....	....	....	12.0,12.6	.23880	25	....	C VI
			Sep 17, 20	....	....	....	....	13.4,14.0	.23889	25	....	C VI
			Sep 21, 20	10.7 to 13.0 (dv)	4 49.9 W	....	....	....	....	25	....	C VI
			Sep 23, 20	....	....	....	....	14.3,15.3	.23888	5	....	C VI
			Sep 24, 20	....	....	12.0 to 14.5(6)	65 23.8 S	....	....	......	EI 25	C VI
			Sep 25, 20	....	....	8.9 to 9.6(3)	65 23.1 S	....	....	......	EI 25	C VI
Cottesloe, *C*.	31 59.3 S	115 44	Nov 18, 14	11.0,14.1	4 42.7 W	....	....	11.9,13.0	.24233	17	....	FB
			Nov 18, 14	14.8,16.4	4 42.2 W	....	....	15.3,16.0	.24241	17	....	FB
			Nov 19, 14	9.8,11.7	4 44.7 W	....	....	10.4,11.2	.24224	24	....	FB
			Nov 19, 14	12.1,12.4	4 41.6 W	....	....	15.1,15.9	.24228	24	....	FB
			Nov 19, 14	14.4,16.4,16.7	4 39.5 W	....	....	....	....	24	....	FB
			Nov 20, 14	9.6,11.6	4 46.2 W	....	....	10.3,11.2	.24220	14	....	FB
			Nov 20, 14	12.1,14.5	4 41.6 W	....	....	12.5,14.2	.24222	14	....	FB
			Nov 21, 14	10.8,14.4	4 42.6 W	....	....	12.4,13.9	.24216	9	....	ALK
			Nov 21, 14	14.9,16.6	4 41.0 W	....	....	15.5,16.1	.24236	9	....	ALK
			Nov 23, 14	9.8,12.1	4 44.7 W	....	....	10.8,11.6	.24206	9	....	ALK
			Nov 23, 14	14.0,16.2	4 41.3 W	....	....	14.6,15.5	.24238	24	....	ALK
			Nov 24, 14	9.8,12.2	4 44.0 W	....	....	10.6,11.6	.24224	24	....	ALK
			Nov 24, 14	12.6,15.7	4 41.2 W	....	....	14.3,15.2	.24240	24	....	ALK
			Nov 25, 14	10.4 to 11.9 (4)	4 45.4 W	....	....	....	....	24	....	FB
			Nov 25, 14	12.8 to 14.5(4)	4 40.6 W	....	....	....	....	14	....	FB
Rottnest Island	32 00.2 S	115 33	Apr 14, 14	8.4,11.0	4 47.6 W	13.4	65 27.3 S	8.8,10.6	.24164	14	14.125	WCP
Norseman	32 12.2 S	121 48	Jun 25, 14	10.9,12.4	4 34.6 W	13.8	64 47.7 S	11.3,12.1	.24692	14	14.1256	WCP
Cardanumbi	32 16.3 S	125 38	Jun 8, 14	14.2,15.6	0 12.5 E	11.1	64 36.2 S	14.6,15.2	.25040	14	14.1256	WCP
Balladonia	32 28.4 S	123 53	Jun 6, 14	10.3,13.8	0 22.7 W	14.8	65 08.6 S	10.8,11.8	.24533	14	14.12	WCP
			Jun 20, 14	....	....	9.4	65 04.2 S	....	....	......	14.1256	WCP
Port Augusta	32 29.7 S	137 46	Aug 6, 14	11.4	4 48.7 E	....	....	13.4	.25607	9	....	ALK
			Aug 7, 14	13.8,15.4	4 53.7 E	10.6	64 07.0 S	14.3,15.0	.25605	9	177.1256	ALK

AUSTRALASIA.

AUSTRALIA—*Continued.*

Station	Latitude	Long. East of Gr.	Date	Declination		Inclination		Hor. Intensity		Instruments		Obs'r
				Local Mean Time	Value	L. M. T.	Value	L. M. T.	Value	Mag'r	Dip Circle	
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Wilmington	32 39.3 S	138 05	Sep 2, '16	....	....	17.2	64 08.6 S	....	....	......	38.12	GFD
			Sep 5, 16	16.6,18.1	5 43.8 E	....	....	17.0,17.8	.25614	6	....	GFD
Melrose	32 48.4 S	138 12	Sep 12, 16	....	....	19.0	64 03.2 S	....	....	......	38.12	GFD
			Sep 13, 16	13.2,15.2	5 47.0 E	....	....	13.6,14.8	.25618	6	....	GFD
Booleroo Center	32 53.0 S	138 21	Sep 20, 16	....	....	16.3	63 58.4 S	....	....	......	38.12	GFD
			Sep 21, 16	15.6	5 40.8 E	....	....	16.3	.25686	6	....	GFD
			Sep 23, 16	15.5,17.6	5 41.5 E	....	....	16.1 17.2	.25637	6	....	GFD
Rabbit-Proof Fence 1	32 54.0 S	119 48	May 21, 14	....	....	16.5	65 48.4 S	....	....	......	14.1256	WCP
			May 22, 14	9.2,10.8	2 25.4 W	....	....	9.6,10.4	.23978	14	....	WCP
Bunbury	33 19.5 S	115 38	Apr 25, 14	11.6,13.4	5 41.8 W	16.0	66 11.5 S	12.1,13.0	.23404	14	14.1256	WCP
Israelite Bay	33 36.4 S	123 48	May 30, 14	....	....	6.9	66 00.8 S	8.2	.24066	14	14.12	WCP
Red Hill, *A*	33 44.5 S	151 04	Jan 12, 16	15.1,16.6	9 16.9 E	....	....	15.8	.26085	14	....	WCP
			Jan 13, 16	10.6,12.6	9 14.4 E	....	....	11.3,12.2	.26100	14	....	WCP
			Jan 13, 16	14.6,16.4	9 19.0 E	....	....	15.1,16.0	.26118	14	....	WCP
			Jan 14, 16	10.8,12.6	9 15.4 E	....	....	11.2,12.1	.26122	14	....	WCP
			Jan 14, 16	15.0,16.5,20.1	9 16.3 E	....	....	15.4,16.2	.26120	17	....	HES
			Jan 14, 16	20.2 to								
			Jan 15, 16	20.0 (dv)	9 17.6 E	....	....	....	....	17	....	P&S
			Jan 15, 16	20.2	9 16.7 E	....	....	....	....	17	....	WCP
			Jan 18, 16	10.7,12.5	9 15.6 E	....	....	11.2,12.1	.26110	17	....	HES
			Jan 18, 16	16.2	9 19.9 E	....	....	15.2,15.8	.26132	17	....	HES
			Jan 19, 16	....	....	11.1	63 18.2 S	....	....	......	223.1356	HES
			Jan 19, 16	....	....	12.6,14.9	63 18.2 S	....	....	......	223.1356	HES
			Jan 19, 16	....	....	16.2	63 17.4 S	....	....	......	223.1356	HES
			Jan 21, 16	....	....	11.9,13.4	63 17.0 S	....	....	......	14.1256	WCP
			Jan 21, 16	....	....	14.8	63 16.4 S	....	....	......	14.1256	WCP
			Jan 31, 16	12.4,12.6,14.5	9 21.3 E	....	....	....	....	14	....	WCP
			Jan 31, 16	14.8,15.1,15.3	9 21.6 E	....	....	....	....	14	....	WCP
			Jan 31, 16	17.0,17.2,17.7	9 19.1 E	....	....	....	....	17	....	HES
			Jan 31, 16	17.8 to								
			Feb 1, 16	17.1 (dv)	9 16.8 E	....	....	....	....	17	....	P&S
			Feb 1, 16	17.2	9 17.8 E	....	....	....	....	17	....	HES
			May 26, 16	....	....	12.1	63 17.8 S	....	....	......	201.(1234)	WCP
			May 27, 16	9.7,11.0	9 13.8 E	....	....	10.0,10.7	.26117	18	....	WCP
Red Hill, *B*	33 44.5 S	151 04	Jan 12, 15	13.5,15.2	9 19.2 E	16.2	63 15.7 S	14.0,14.8	.26170	14	14.1256	WCP
			Jan 12, 16	15.1,16.6	9 15.3 E	....	....	15.8	.26110	17	....	HES
			Jan 13, 16	10.6,12.6	9 13.7 E	....	....	11.2,12.2	.26111	17	....	HES
			Jan 13, 16	14.6,16.4	9 19.2 E	....	....	15.1,16.0	.26129	17	....	HES
			Jan 14, 16	10.8,12.6	9 14.9 E	....	....	11.2,12.0	.26135	17	....	HES
			Jan 14, 16	15.0,16.5	9 14.2 E	....	....	15.4,16.2	.26089	14	....	WCP
			Jan 18, 16	10.7,12.5	9 13.2 E	....	....	11.2,12.1	.26109	14	....	WCP
			Jan 18, 16	14.8,16.2	9 16.2 E	....	....	15.2,15.8	.26136	14	....	WCP
			Jan 19, 16	....	....	11.1	63 18.5 S	....	....	......	14.1256	WCP
			Jan 19, 16	....	....	12.6,14.9	63 19.2 S	....	....	......	14.1256	WCP
			Jan 19, 16	....	....	16.2	63 17.5 S	....	....	......	14.1256	WCP
			Jan 21, 16	....	....	11.9	63 19.6 S	....	....	......	223.1356	HES
			Jan 21, 16	....	....	13.4,14.8	63 18.2 S	....	....	......	223.1356	HES
			Jan 31, 16	12.4,12.6,14.5	9 20.2 E	....	....	....	....	17	....	HES
			Jan 31, 16	14.8,15.1,15.3	9 20.4 E	....	....	....	....	17	....	HES
			Jan 31, 16	17.0,17.2	9 16.6 E	....	....	....	....	14	....	WCP
Esperance	33 51.4 S	121 53	May 27, 14	10.8,13.7	2 23.2 W	15.3	66 34.6 S	11.2,13.3	.23371	14	14.1256	WCP
Hopetoun	33 53.6 S	120 09	May 19, 14	9.6,11.5	3 22.1 W	12.5	66 25.0 S	10.1,11.0	.23554	14	14.12	WCP
Eleven-Mile Dam, *A*	34 16.8 S	117 45	Jul 23, 16	....	....	15.3	67 13.4 S	....	....	......	201.(1)	WCP
Eleven-Mile Dam, *B*	34 16.8 S	117 45	Jul 23, 16	....	....	14.7	67 19.0 S	....	....	......	201.(1)	WCP
Kapunda	34 20.4 S	138 55	Dec 23, 15	16.5,18.2	6 30.2 E	15.2	65 11.4 S	17.0,18.8	.24810	6	226.12	GFD
Cape Leeuwin	34 22.1 S	115 08	Apr 28, 14	10.4,12.0	5 50.8 W	15.7	67 37.1 S	10.9,11.7	.22404	14	14.1256	WCP
Marra	34 25.4 S	118 47	May 16, 14	10.7,12.9	6 24.8 W	15.3	68 47.3 S	11.2,12.5	.21899	14	14.1256	WCP
Angaston	34 30.5 S	139 03	Dec 21, 15	14.9,16.7	6 43.6 E	12.0	65 43.0 S	15.4,16.4	.24394	6	226.12	GFD
Roseworthy	34 32.0 S	138 45	Sep 6, 15	12.2,17.1	6 11.8 E	....	....	13.7,16.2	.24592	6	....	GFD
			Sep 7, 15	....	....	12.1	65 40.2 S	....	....	......	226.12	GFD
Gawler	34 37.1 S	138 44	Dec 16, 15	....	....	16.4	65 52.6 S	....	....	......	226.12	GFD
			Dec 17, 15	14.1,17.0	6 00.6 E	....	....	14.9,16.5	.24454	6	....	GFD
Adelaide (South Park)	34 56.2 S	138 36	Mar 6, 14	16.3	5 48.4 E	14.4	66 08.2 S	16.9	.24273	14	14.1256	FB
Port Frankland	34 59.8 S	116 49	May 5, 14	10.4,12.6	5 56.3 W	13.7	67 37.8 S	11.3,12.2	.22476	14	14.1256	WCP
Blackwood, *A*	35 00.6 S	138 36	Mar 11, 14	10.5	5 13.3 E	....	....	12.4,14.6	.24212	24	....	WCP
			Mar 11, 14	....	....	....	....	16.2,17.1	.24210	24	....	WCP
			Mar 12, 14	10.4 to 16.3 (4)	5 20.5 E	....	....	11.2-15.6(4)	.24185	14	....	WCP
			Mar 13, 14	11.5,15.6,16.1	5 19.9 E	....	....	13.9-17.8(4)	.24204	9	....	WCP
			Mar 14, 14	8.9	5 14.8 E	10.7	66 08.2 S	....	....	9	14.1256	K&P
Blackwood, *B*	35 00.6 S	138 36	Mar 11, 14	10.5 to 17.6(4)	5 19.9 E	....	....	12.4-17.1(4)	.24204	9	....	EK
			Mar 12, 14	10.4 to 16.3(4)	5 19.9 E	....	....	11.2-15.6(4)	.24188	24	....	EK
			Mar 13, 14	11.5,15.6,16.1	5 19.8 E	....	....	13.9-17.8(4)	.24211	14	....	EK
			Mar 14, 14	8.9	5 14.9 E	....	....	....	....	14	....	EK

AUSTRALASIA.

AUSTRALIA—*Concluded.*

Station	Latitude	Long. East of Gr.	Date	Declination		Inclination		Hor. Intensity		Instruments		Obs'r
				Local Mean Time	Value	L. M. T.	Value	L. M. T.	Value	Mag'r	Dip Circle	
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Blackwood, *C*	35 00.6 S	138 36	Mar 11, '14	10.5 to 17.6(4)	5 19.8 E			12.4-17.1(4)	.24213	14		FB
			Mar 12, 14	10.4 to 16.3(4)	5 20.0 E			11.2-15.6(4)	.24191	9		FB
			Mar 13, 14	11.5, 15.6, 16.1	5 20.4 E			13.9-17.8(4)	.24209	24		FB
			Mar 14, 14	8.9	5 15.8 E					24		FB
Albany	35 01.3 S	117 55	May 9, 14	11.1, 14.2	5 18.3 W	15.6	67 20.7 S	12.2, 13.8	.22822	14	14.1256	WCP
			Jun 18, 16	11.8, 13.2	5 12.2 W	14.2	67 26.9 S	12.1, 12.9	.22770	18	201.(1234)	WCP
Nairne	35 02.4 S	138 54	Jan 9, 18	13.9	6 10.5 E			14.6, 16.2	.24050	6		D&G
			Jan 10, 18	14.6, 17.0	6 06.6 E	16.1	66 03.3 S			6	38.34	D&G
Murray Bridge	35 07.2 S	139 16	Mar 20, 14	11.0, 13.8	5 31.8 E	15.3	66 18.2 S	11.5, 13.0	.24051	14	14.1256	K,P,K
Goolwa	35 30.0 S	138 47	Jan 16, 18			15.9, 16.0	66 33.3 S				38.13	D&G
			Jan 17, 18	11.2, 16.2	5 28.5 E			12.3, 15.4	.23781	6		D&G
			Jan 18, 18			12.0	66 38.8 S				38.4	D&G
Port Victor	35 31.8 S	138 37	Mar 17, 14			16.5	66 39.4 S				14.12	P&K
			Mar 18, 14	10.4, 14.5	5 43.6 E	15.6	66 39.2 S	10.9, 13.1	.23690	14	14.56	P&K
Port Victor, *Secondary*	35 31.8 S	138 37	Mar 18, 14			15.3, 15.9	66 39.8 S				EI 24	EK
Border Town	36 18.5 S	140 46	Mar 21, 14	12.1, 14.7	6 22.4 E	15.9	67 04.2 S	12.9, 14.2	.23600	14	14.12	P&K
			May 26, 16			17.6	67 07.7 S				38.12	GFD
			May 27, 16	10.3, 12.1	6 14.0 E			10.8, 11.6	.23520	6		GFD
Kingston	36 49.8 S	139 51	Mar 6, 17	14.4, 16.9	5 49.2 E	11.0	67 51.8 S	15.0, 16.3	.23182	6	38.12	D&G
Kybyolite	36 53.2 S	140 55	May 16, 17			14.6	67 43.8 S				38.34	D&G
			May 19, 17	14.0, 15.8	5 55.1 E			14.6, 15.5	.22864	6		D&G
Naracoorte	36 57.0 S	140 45	May 29, 16	15.5	6 25.9 E			16.7	.23124	6		G&B
			May 30, 16	15.8	6 21.8 E					6		G&B
Robe	37 09.8 S	139 45	Feb 26, 17	13.1, 15.3	5 31.9 E			13.8, 14.9	.22771	6		D&G
			Feb 27, 17			12.3	67 58.7 S				38.12	D&G
Long Gully	37 18.2 S	139 50	Feb 28, 17	15.1, 16.6	5 36.0 E	14.0	68 09.8 S	15.6, 16.2	.22746	6	38.12	D&G
Penola	37 22.6 S	140 50	Dec 20, 16	12.4, 17.6	6 32.6 E			15.0, 16.7	.22838	6		D&G
			Dec 21, 16			12.2	67 58.0 S				38.12	D&G
Beachport	37 28.8 S	140 00	Mar 23, 14	13.8, 16.0	5 33.1 E			14.4, 15.4	.22530	14		P&K
			Mar 24, 14			11.0	68 25.8 S				14.12	P&K
Beachport, *Secondary*	37 28.8 S	140 00	Mar 23, 14			16.1, 16.5	68 25.4 S				EI 24	EK
			Mar 24, 14	9.7	5 27.8 E					24		EK
Melbourne, *Dip-Circle Pier*	37 49.9 S	144 58	Mar 2, 14			11.4	67 46.5 S				172[1]	EK
			Mar 2, 14			14.9	67 44.7 S				172[1]	EK
			Mar 3, 14			10.3	67 46.0 S				14.1256	EK
			Mar 3, 14			12.5	67 44.8 S				14.1256	EK
Melbourne, *B*	37 49.9 S	144 58	Mar 2, 14			11.5	67 46.4 S				14.1256	FB
			Mar 2, 14			14.9	67 44.6 S				14.1256	FB
			Mar 3, 14			10.2	67 46.7 S				172[1]	FB
			Mar 3, 14			12.4	67 45.0 S				172[1]	FB
			May 31, 16	11.6, 13.3, 13.6	8 01.1 E	14.8	67 52.6 S	12.0, 12.9	.22952	18	201.(12)	WCP
			May 31, 16					14.0	.22932	18		WCP
Mount Ruskin	38 03.0 S	140 58	Feb 25, 18			13.5	68 35.2 S				226.12	D&G
			Feb 26, 18	10.9, 15.4	6 19.0 E			11.5, 14.8	.22254	6		D&G
Port MacDonnell	38 03.4 S	140 42	Feb 12, 18	15.3, 17.5	6 06.0 E			15.9, 17.0	.22260	6		D&G
			Feb 14, 18			11.7	68 37.8 S				226.12	D&G
Currie, *B*	39 54.3 S	143 51	Jan 20, 14	14.5	8 02.5 E	15.9	69 37.2 S	14.9	.21543	14	14.1	EK
Currie, *A*	39 56.0 S	143 50	Jan 18, 14			15.6	69 39.6 S				14.1256	EK
			Jan 19, 14	10.5, 12.7, 15.5	8 09.1 E			11.0, 11.8	.21513	14		EK
Currie, *A*, *Secondary*	39 56.0 S	143 50	Jan 19, 14	16.3	8 19 E					14		EK
White Mark	40 07.4 S	148 02	Jan 22, 14	9.8, 11.5, 11.8	9 36.5 E	14.5	69 18.3 S	10.2, 11.1	.21786	17	172.156	FB
			Jan 23, 14	9.2, 10.0	9 30.0 E					*172*		FB
			Jan 23, 14	10.9	9 35.4 E					17		FB
			Jan 23, 14	11.1 to								
			Jan 24, 14	11.4 (dv)	9 38.1 E					17		FB
White Mark *Secondary*	40 07.4 S	148 02	Jan 23, 14	10.0	9 31.1 E					*172*		FB
Gladstone	40 57.6 S	148 00	Jan 14, 14	9.0, 10.8	9 44.1 E	14.7	69 59.8 S	9.5, 10.4	.21180	17	172.56	FB
			Jan 14, 14	11.3, 11.6	9 50.9 E					17		FB
Latrobe	41 14.8 S	146 27	Jan 14, 14	16.1	9 36.9 E			16.7	.20928	14		EK
			Jan 15, 14			12.5	70 25.2 S				14.12	EK
Scamander, *A*	41 26.7 S	148 18	Jan 12, 14	11.5, 13.0	9 55.6 E	14.6	70 21.6 S	12.0, 12.7	.20929	17	172.156	EK
Scamander, *B*	41 26.7 S	148 18	Jan 12, 14	15.6	9 49.8 E					*172*		EK
Strahan	42 09.6 S	145 21	Jan 18, 14	15.1, 15.7	9 01.8 E	14.1	71 17.7 S	16.1	.20183	17	172.12	FB
Oatlands	42 17.2 S	147 23	Jan 9, 14	10.7, 12.5	9 17.7 E	15.2	71 00.8 S	11.1, 12.0	.20268	14	14.12	K&B
Hobart, *D*	42 52.2 S	147 21	Jan 7, 14	10.3, 11.8	9 01.6 E	12.6	71 23.4 S	10.7, 11.4	.19932	14	14.12	K&B
			Jan 7, 14	14.5, 15.8	9 02.4 E					14		K&B
Hobart, *D*, *Secondary*	42 52.2 S	147 21	Jan 7, 14	16.8	9 06.8 E					14		EK
Southport, *A*	43 25.9 S	147 01	Jan 2, 14	15.4, 17.1	10 56.6 E			16.0, 16.8	.19003	14		EK
			Jan 3, 14			10.5	72 24.2 S				14.12	EK
Southport, *B*	43 25.9 S	147 01	Jan 3, 14	15.0	10 21.8 E	14.8	72 15 S			14	14.2	EK
Southport, *C*	43 26.2 S	147 00	Jan 4, 14	16.0	10 04.9 E	15.5	72 12.5 S	16.8	.19401	14	14.1	EK

[1] Mean of six needles, Nos. 1, 2, 5, 6 of 172 and Nos. 7, 8 of 178.

AUSTRALASIA.

NEW ZEALAND.

Station	Latitude	Long. East of Gr.	Date	Declination: Local Mean Time	Declination: Value	Inclination: L. M. T.	Inclination: Value	Hor. Intensity: L. M. T.	Hor. Intensity: Value	Instruments: Mag'r	Instruments: Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Te Awamutu	38 00.4 S	175 20	Mar 28, '16	....	....	16.8	63 04.2 S	....	....	......	14.1256	WCP
			Mar 29, 16	10.5,12.1	15 17.4 E	....	....	10.8,11.7	.25672	14	....	WCP
Rotorua	38 07.9 S	176 16	Mar 25, 16	11.1,13.2	14 48.2 E	14.3	63 01.4 S	11.5,12.4	.25542	14	14.1256	WCP
Eketahuna	40 38.8 S	175 43	Apr 6, 16	....	....	17.0	65 11.9 S	....	....	......	14.1256	WCP
			Apr 7, 16	9.4,10.9	16 08.6 E	....	....	9.8,10.6	.24268	14	....	WCP
Petone	41 13.5 S	174 53	Apr 4, 16	13.0	16 19.4 E	12.6	65 57.0 S	13.4	.23858	14	14.12	WCP
Mount Victoria	41 18.7 S	174 47	Apr 3, 16	12.0,14.8	16 27.8 E	12.0	65 56.8 S	13.5,14.4	.23816	14	14.1256	WCP
Cass	43 01.5 S	171 48	Dec 12, 15	14.0,15.8	16 45.0 E	....	....	14.5,15.4	.22590	17	....	HES
			Dec 13, 15	....	....	8.9	67 48.7 S	....	....	......	223.1356	HES
Springfield	43 20.6 S	171 57	Mar 2, 16	8.5,10.3	16 42.2 E	11.8	68 05.4 S	9.0,10.0	.22404	14	14.1256	WCP
New Brighton Beach	43 31.6 S	172 45	Dec 10, 15	14.4,15.8	17 06.8 E	16.7	67 56.0 S	14.8,15.5	.22538	17	223.56	HES
Christchurch, *East Pier*	43 31.8 S	172 37	Nov 10, 15	15.3	16 52.1 E	....	....	15.9,17.1	.22417	5	....	C IV
			Nov 11, 15	10.0	16 43.7 E	....	....	10.7,12.1	.22368	5	....	C IV
			Nov 11, 15	14.5,14.9	16 51.6 E	....	....	15.6,16.5	.22404	5	....	C IV
			Nov 12, 15	9.1,11.9	16 44.2 E	....	....	9.7,10.9	.22358	25	....	C IV
			Nov 15, 15	8.9,11.2	16 44.0 E	....	....	9.5,10.6	.22371	25	....	C IV
			Nov 15, 15	11.9,12.3	16 48.0 E	....	....	16.1,17.2	.22414	25	....	C IV
			Nov 15, 15	18.0,18.3	16 49.8 E	....	....	....	....	5	....	C IV
			Nov 23, 15	....	....	....	....	10.3 to 17.2 (5)	.22393	5	....	C IV
			Nov 24, 15	....	....	....	....	9.7,10.8	.22361	5	....	C IV
			Nov 24, 15	....	....	....	....	14.4,15.2	.22383	5	....	C IV
			Nov 24, 15	....	....	....	....	15.8,16.6	.22408	5	....	C IV
			Nov 25, 15	....	....	....	....	8.8 to 17.3 (12)	.22386	5	....	C IV
			Nov 26, 15	9.2 to 16.7 (6)	16 48.5 E	....	....	9.6 to 16.3 (6)	.22388	5	....	C IV
			Dec 21, 15	11.5 to 18.0 (6)	16 52.1 E	....	....	11.9 to 17.6 (6)	.22398	17	....	HES
			Dec 22, 15	14.0,15.7	16 52.4 E	....	....	14.4,15.3	.22412	17	....	HES
			Dec 22, 15	16.2,18.0	16 51.2 E	....	....	16.7,17.6	.22412	17	....	HES
			Dec 24, 15	4.4, 7.2	16 45.0 E	....	....	5.8, 6.8	.22408	17	....	HES
			Feb 27, 16	6.0,10.7,12.1	16 48.8 E	15.2	68 02.0 S	6.6, 7.7	.22382	14	14.1256	WCP
			Feb 27, 16	....	....	....	....	11.2	.22333	14	....	WCP
			Apr 9, 16	10.8,12.8	16 49.5 E	....	....	11.2,12.2	.22344	14	....	WCP
			Apr 11, 16	....	....	10.2	68 01.8 S	....	....	......	14.1256	WCP
			Nov 2, 20	....	....	....	....	10.8,12.3	.22266	5	....	C VI
			Nov 2, 20	....	....	....	....	14.7,15.6	.22284	5	....	C VI
			Nov 2, 20	....	....	....	....	16.4	.22278	5	....	C VI
			Nov 3, 20	12.8 to 16.1 (6)	17 06.2 E	....	....	10.9	.22255	5	....	C VI
Christchurch, *West Pier*	43 31.8 S	172 37	Nov 14, 15	....	....	6.3 to 10.8 (12)	68 01.7 S	....	....	......	EI 25	C IV
			Dec 19, 15	....	....	6.2, 8.9	68 03.6 S	....	....	......	223.1356	HES
			Dec 22, 15	....	....	7.0, 8.8	68 03.8 S	....	....	......	223.1356	HES
			Dec 23, 15	....	....	5.8, 7.6	68 02.8 S	....	....	......	223.1356	HES
			Nov 5, 20	....	....	0.5 to 2.3 (6)	68 10.6 S	....	....	......	EI 25	C VI
Christchurch, *Brass Pipe*	43 31.8 S	172 37	Nov 8, 15	....	....	....	....	14.8,16.0	.22406	5	....	C IV
			Nov 9, 15	9.0,11.3,11.8	16 43.9 E	....	....	9.7,10.8	.22332	5	....	C IV
			Nov 10, 15	8.7,11.0	16 43.6 E	....	....	9.3,10.3	.22360	5	....	C IV
			Nov 10, 15	11.8,12.1	16 45.8 E	....	....	....	....	5	....	C IV
			Nov 10, 15	15.3	16 51.1 E	....	....	15.9,17.1	.22406	25	....	C IV
			Nov 11, 15	10.0,14.5,14.9	16 48.8 E	....	....	10.7,12.1	.22361	25	....	C IV
			Nov 11, 15	....	....	....	....	15.6,16.5	.22412	25	....	C IV
			Nov 14, 15	....	....	6.3 to 10.8 (12)	68 04.1 S	....	....	......	EI 3	C IV
			Nov 15, 15	18.1,18.3	16 48.5 E	....	....	....	....	25	....	C IV
			Nov 16, 15	....	....	8.8 to 11.9 (12)	68 05.1 S	....	....	......	EI 3	C IV
			Nov 18, 15	5.4 to 7.8 (dv)	16 43.7 E	....	....	....	....	25	....	C IV
			Nov 18, 15	14.5 to 16.5 (dv)	16 52.2 E	....	....	....	....	25	....	C IV
			Nov 19, 15	9.8 to 12.1 (dv)	16 45.8 E	....	....	....	....	25	....	C IV
			Nov 19, 15	13.8 to 15.9 (dv)	16 51.9 E	....	....	....	....	25	....	C IV
			Nov 20, 15	10.8	16 46.1 E	....	....	....	....	25	....	C IV
			Nov 20, 15	14.4 to 17.2(7)	16 51.6 E	....	....	....	....	25	....	C IV
			Nov 22, 15	8.6 to 15.9 (5)	16 46.5 E	....	....	8.8 to 15.5 (8)	.22380	5	....	C IV
			Nov 26, 15	9.2 to 16.7 (6)	16 47.3 E	....	....	9.6 to 16.3 (6)	.22387	25	....	C IV
			Nov 29, 15	14.2 to 16.1(9)	16 48.8 E	....	....	....	....	25	....	C IV
			Apr 4, 16	11.7,16.6	16 49.8 E	....	....	12.3,16.2	.22372	5	....	C IV
			Apr 5, 16	12.0,12.3	16 50.7 E	....	....	10.4,11.6	.22348	5	....	C IV

AUSTRALASIA

NEW ZEALAND—*Continued.*

Station	Latitude	Long. East of Gr.	Date	Declination: Local Mean Time	Declination: Value	Inclination: L. M. T.	Inclination: Value	Hor. Intensity: L. M. T.	Hor. Intensity: Value	Instruments: Mag'r	Instruments: Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Christchurch, *Brass Pipe—Concluded*	43 31.8 S	172 37	Apr 5, '16	14.2,16.3	16 51.0 E	....	....	14.6,15.9	.22375	5	....	C IV
			Apr 6, 16	12.0	16 51.3 E	....	....	12.4	.22368	25	....	C IV
			Apr 6, 16	15.1,15.4	16 53.3 E	....	....	14.6,15.8	.22382	25	....	C IV
			Apr 7, 16	10.2	16 44.6 E	....	....	9.8	.22341	25	....	C IV
			Apr 7, 16	10.6,12.5	16 49.0 E	....	....	11.1,12.1	.22352	25	....	C IV
			Apr 8, 16	10.3,12.0	16 47.2 E	....	....	10.8,11.6	.22352	25	....	C IV
			Apr 10, 16	9.4 to 15.2 (4)	16 49.1 E	....	....	9.7 to 14.9 (6)	.22364	25	....	C IV
			Apr 11, 16	6.9 to 10.5 (dv)	16 44.5 E	....	....	....	....	25	....	C IV
			Apr 12, 16	9.3 to 16.4 (5)	16 49.4 E	....	....	9.6 to 16.1 (8)	.22362	25	....	C IV
			Apr 13, 16	9.5 to 15.8 (4)	16 47.8 E	....	....	9.8 to 15.4 (6)	.22370	25	....	C IV
			Apr 14, 16	9.3,10.6	16 45.9 E	....	....	9.6,10.2	.22382	25	....	C IV
			Apr 17, 16	9.8	16 45.3 E	....	....	....	....	25	....	C IV
			Apr 17, 16	14.2,16.2	16 49.4 E	....	....	14.6,15.7	.22382	5	....	C IV
			Apr 18, 16	7.7 to 11.0 (dv)	16 47.5 E	....	....	....	....	25	....	C IV
			Apr 19, 16	8.9 to 11.7 (dv)	16 47.3 E	....	....	....	....	25	....	C IV
			Apr 19, 16	13.7	16 52.5 E	....	....	....	....	25	....	C IV
			Apr 20, 16	9.1 to 12.6 (dv)	16 47.2 E	....	....	....	....	25	....	C IV
			Apr 24, 16	9.5,11.4	16 47.0 E	....	....	9.8,11.1	.22349	25	....	C IV
			Apr 26, 16	9.9 to 15.4 (4)	16 51.0 E	....	....	10.3 to 15.1 (6)	.22286	25	....	C IV
			Apr 27, 16	9.4 to 15.5 (4)	16 48.7 E	....	....	9.7 to 15.2 (6)	.22335	25	....	C IV
			Apr 28, 16	9.5,10.8	16 49.0 E	14.7 to 16.4 (6)	68 05.8 S	9.8,10.5	.22326	25	EI 25	C IV
			Apr 29, 16	....	....	9.4 to 11.9 (8)	68 07.6 S	....	....	....	EI 25	C IV
			May 2, 16	....	....	8.7 to 12.5 (13)	68 05.2 S	....	....	....	EI 3	C IV
			Oct 26, 20	15.4	17 05.4 E	....	....	15.9	.22293	5	....	C VI
			Oct 27, 20	11.0,12.6,15.2	17 03.2 E	....	....	11.5,12.1	.22250	5	....	C VI
			Oct 27, 20	....	....	....	....	15.7	.22294	5	....	C VI
			Oct 28, 20	9.8,11.8	17 00.0 E	....	....	10.5,11.4	.22246	25	....	C VI
			Oct 28, 20	12.2,12.3	17 05.5 E	....	....	14.6,15.2	.22290	25	....	C VI
			Oct 28, 20	16.0,16.2	17 05.1 E	....	....	....	....	5	....	C VI
			Oct 29, 20	6.2 to 7.8 (dv)	16 56.9 E	....	....	....	....	25	....	C VI
			Nov 7, 20	....	....	....	....	6.8, 8.4	.22236	5	....	C VI
Christchurch, *Jarrah Peg*	43 31.8 S	172 37	Nov 7, 15	....	....	6.2 to 9.9 (10)	68 04.9 S	....	....	....	EI 25	C IV
			Nov 8, 15	....	....	9.6, 9.9	68 04.4 S	10.6,11.4	.22333	25	EI 25	C IV
			Nov 8, 15	....	....	11.9,12.1	68 04.2 S	14.8,16.0	.22389	25	EI 25	C IV
			Nov 9, 15	9.0,11.3,11.8	16 44.8 E	....	....	9.6,10.8	.22341	25	....	C IV
			Nov 10, 15	8.7,11.0	16 43.2 E	....	....	9.3,10.3	.22346	25	....	C IV
			Nov 10, 15	11.7,12.1	16 46.8 E	....	....	....	....	25	....	C IV
			Nov 12, 15	8.1,11.9	16 44.6 E	....	....	9.7,10.9	.22355	5	....	C IV
			Nov 15, 15	8.9,11.2	16 45.8 E	....	....	9.5,10.5	.22376	5	....	C IV
			Nov 15, 15	11.9,12.3	16 49.6 E	....	....	16.2,17.2	.22427	5	....	C IV
			Nov 16, 15	....	....	8.8 to 11.9 (12)	68 04.3 S	....	....	....	EI 25	C IV
			Nov 16, 15	....	....	13.4 to 16.3 (12)	68 04.0 S	....	....	....	EI 3	C IV
			Nov 17, 15	9.4 to 14.8 (4)	16 50.5 E	....	....	10.4 to 15.9 (7)	.22354	25	....	C IV
			Nov 17, 15	16.2 to 17.9 (dv)	16 53.1 E	....	....	....	....	25	....	C IV
			Nov 23, 15	....	....	9.6 to 18.0 (10)	68 03.4 S	....	....	....	EI 25	C IV
			Nov 24, 15	....	....	8.8 to 11.6 (5)	68 04.4 S	....	....	....	EI 25	C IV
			Nov 29, 15	14.2 to 16.1 (9)	16 52.3 E	....	....	....	....	5	....	C IV
			Apr 4, 16	11.7,16.6	16 50.2 E	....	....	12.3,16.2	.22366	25	....	C IV
			Apr 5, 16	12.0,12.3	16 51.2 E	....	....	10.4,11.6	.22339	25	....	C IV
			Apr 5, 16	14.2,16.3	16 52.1 E	....	....	14.6,15.9	.22370	25	....	C IV
			Apr 6, 16	12.0,15.1,15.4	16 53.1 E	....	....	12.4,14.6	.22374	5	....	C IV
			Apr 7, 16	10.2 to 12.5 (3)	16 48.0 E	....	....	9.8 to 12.1 (3)	.22346	5	....	C IV
			Apr 7, 16	15.1 to 17.4 (dv)	16 53.8 E	....	....	....	....	25	....	C IV
			Apr 11, 16	13.9 to 15.3 (dv)	16 52.9 E	....	....	....	....	25	....	C IV
			Apr 17, 16	14.2,16.2	16 50.9 E	....	....	14.6,15.7	.22381	25	....	C IV
			Apr 18, 16	13.8 to 17.1 (dv)	16 51.8 E	....	....	....	....	25	....	C IV
			Apr 28, 16	....	....	14.7 to 16.4 (6)	68 06.6 S	....	....	....	EI 3	C IV

AUSTRALASIA.

NEW ZEALAND—*Concluded.*

Station	Latitude	Long East of Gr.	Date	Declination Local Mean Time	Declination Value	Inclination L M T	Inclination Value	Hor Intensity L M T	Hor Intensity Value	Instruments Mag'r	Instruments Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c g s			
Christchurch, *Jarrah Peg—Concluded* .	43 31 8 S	172 37	Apr 29, '16			9 5 to 11 9 (8)	68 08 5 S				EI 3	C IV
			May 2, 16			8 7 to 16 2 (17)	68 04 3 S	15 4	22360	25	EI 25	C IV
			May 3, 16			8 5 to 16 1 (8)	68 04 4 S	9 2 to 15 6 (5)	22355	25	EI 25	C IV
			May 4, 16			9 6,11 6	68 05 4 S	10 3,11 0	22338	25	EI 25	C IV
			May 7, 16			8 1, 9 0	68 05 6 S				201 (1234)	WCP
			May 7, 16			9 8	68 05 8 S				201 (1234)	WCP
			Oct 26, 20	15 4	17 06 6 E			15 9 .	22298	25		C VI
			Oct 27, 20	11 0,12 6	17 04 3 E			11 6,12 1	22252	25		C VI
			Oct 27, 20	15 2,16 3,16 4	17 06 5 E			15 7	22290	25		C VI
			Oct 28, 20	9 9,11 8	17 01 0 E			10 5,11 3	22240	5		C VI
			Oct 28, 20	12 2,12 3	17 06 1 E			14 6,15 2	22290	5		C VI
			Oct 28, 20	16 0,16 2	17 06 2 E					25		C VI
			Oct 29, 20	5 6	17 00 4 E					25		C VI
			Oct 29, 20					12 5,14 7	22268	5		C VI
			Oct 29, 20					15 5	22292	5		C VI
			Oct 30, 20					9 8,10 3	22245	5		C VI
			Oct 30, 20					11 1,12 4	22247	5		C VI
			Oct 31, 20			6 6 to 9 1 (6)	68 10 1 S				EI 25	C VI
			Nov 4, 20	14 9,15 0,15 4	17 08 3 E			.		5		C VI
			Nov 4, 20	15 6,15 9,16 1	17 08 7 E			.		5	.	C VI
			Nov 11, 20	16 8 to 17 7 (dv)	17 06 2 E			.		25		C VI
Queenstown	45 02 1 S	168 42	Mar 6, 16	10 4,12 0	17 15 8 E	15 2	69 54 0 S	10 8,11 6	21032	14	14 1256	WCP
Kingston	45 19 7 S	168 45	Mar 7, 16	13 5,15 9	17 29 0 E			14 5,15 5	20930	14	.	WCP
			Mar 8, 16			9 4	70 04 6 S				14 1256	WCP
Te Anau	45 25 1 S	167 44	Mar 13, 16	9 1,14 9	16 42 2 E	11 5	70 28 5 S	13 8,14 5	20619	14	14 1256	WCP
Manapouri . .	45 33 0 S	167 38	Mar 10, 16	9 3,14 2,16 1	16 33 5 E			14 9,15 8	20471	14		WCP
			Mar 12, 16			11 1	70 41 1 S				14 1256	WCP
Clinton	46 12 6 S	169 26	Mar 15, 16	9 3,10 8 .	18 27 8 E	11 8	70 46 5 S	9 7,10 5	20410	14	14 1256	WCP

EUROPE.

GREAT BRITAIN

Station	Latitude	Long East of Gr.	Date	Declination Local Mean Time	Declination Value	Inclination L M T	Inclination Value	Hor Intensity L M T	Hor Intensity Value	Instruments Mag'r	Instruments Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c g s			
Eskdalemuir, *Pier 2*	55 18 9 N	356 48	Sep 16, '15	11 0,11 4,11 7	17 38 7 W				.	26		EK
			Sep 17, 15	10 2 to 11 7 (6)	17 42 5 W			14 6,15 4	16755	26	.	EK
			Sep 18, 15	.			.	9 9,10 8	16743	26		EK
			Sep 18, 15	.				11 4,12 2	16741	26	.	EK
			Sep 20, 15	10 2 to 11 7 (6)	17 35 8 W					26		EK
Eskdalemuir, *Pier 3*	55 18 9 N	356 48	Sep 20, 15	.		14 9 to 16 5 (6)	69 36 7 N				EI 26	EK
			Sep 21, 15	.		10 7(3)	69 38 3 N	.			EI 26	EK
Eskdalemuir, *Pier 5* .	55 18 9 N	356 48	Sep 21, 15	14 5,15 2,15 8	17 39 5 W					26		EK
			Sep 22, 15	10 3,10 7,10 9	17 36 8 W			11 7,12 4	16754	26		EK
			Sep 25, 15	.				10 0,10 8	16730	26		EK
			Sep 25, 15	.				14 3,15 1	16756	26		EK
Eskdalemuir, *Pier 6*	55 18 9 N	356 48	Sep 23, 15			11 1 to 14 4 (5)	69 39 3 N[1]				EI 26	EK
			Sep 24, 15	.		10 2 to 11 8 (6)	69 38 8 N				EI 26	EK
Stonyhurst, *A* .	53 50 7 N	357 32	Sep 8, 15	15 3 to 17 3 (6)	16 35 8 W					26		EK
			Sep 9, 15			.		10 1 to 16 1 (6)	17339	26		EK
			Sep 10, 15	. .		10 7 to 15 4 (6)	68 40 4 N				EI 26	EK
			Sep 11, 15	10 6,11 3	16 36 9 W					26		EK
			Sep 11, 15	14 8,16 2	16 39 6 W		.			26		EK
			Sep 13, 15	.				10 2,10 9	17332	26		EK
			Sep 13, 15	.				14 7,15 5	17342	26		EK
Stonyhurst, *B* . .	53 50 7 N	357 32	Sep 6, 15	11 5 to 16 0 (7)	16 37.2 W					26		EK
			Sep 7, 15	.		.	.	9 4,10 3	17297	26		EK
			Sep 7, 15			15 1 to 16 6 (5)	68 40 9 N	11 0,11 8	17318	26	EI 26	EK
			Sep 8, 15	.		11 6 (3)	68 42 1 N	9 8,10 6	17304	26	EI 26	EK

[1] Magnetic storm

EUROPE.

GREAT BRITAIN—*Concluded.*

Station	Latitude	Long. East of Gr.	Date	Declination		Inclination		Hor. Intensity		Instruments		Obs'r
				Local Mean Time	Value	L. M. T.	Value	L. M. T.	Value	Mag'r	Dip Circle	
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Greenwich Observatory, *Declinometer Station*	51 28.6 N	00 00	Aug 24, '15	11.2 to 12.4 (6)	15 00.2 W	....	....	....	....	26	....	EK
			Aug 27, 15	10.1 to 12.3 (7)	14 59.8 W	....	....	....	....	26	....	EK
Greenwich Observatory, *Intensity Pier*	51 28.6 N	00 00	Aug 18, 15	....	....	....	....	10.4 to 16.5 (6)	.18494	26	....	EK
			Aug 21, 15	....	....	11.6 to 12.9 (6)	66 49.1 N	....	....	......	EI 26	EK
			Aug 23, 15	11.1 to 12.4 (6)	15 05.5 W	....	....	....	....	26	....	EK
			Oct 4, 15	....	....	....	....	15.5,16.4	.18500	26	....	EK
			Oct 5, 15	....	....	....	....	9.9,10.7	.18484	26	....	EK
			Oct 5, 15	....	....	....	....	12.9	.18483	26	....	EK
			Oct 6, 15	....	....	....	....	10.2	.18496	26	....	EK
			Apr 5, 19	....	....	....	....	14.4,16.1	.18444	13	....	FB
			Apr 6, 19	....	....	....	....	10.1,11.1	.18416	13	....	FB
			Apr 6, 19	....	....	....	....	11.9,14.6	.18432	13	....	FB
Greenwich Observatory, *Tent 1915*	51 28.6 N	00 00	Aug 14, 15	11.1,12.6	14 58.1 W	....	....	11.5,12.2	.18490	26	....	EK
			Aug 16, 15	10.8,12.4	15 00.8 W	....	....	11.2,12.0	.18492	26	....	EK
			Aug 16, 15	14.7,16.2	15 01.2 W	....	....	15.1,15.9	.18516	26	....	EK
			Aug 17, 15	10.8,12.4	15 01.2 W	....	....	11.2,11.9	.18490	26	....	EK
			Aug 19, 15	....	....	11.1 to 12.8 (6)	66 51.4 N	....	....	......	EI 26	EK
			Aug 20, 15	....	....	11.4 to 12.8 (6)	66 50.4 N	....	....	......	EI 26	EK
Greenwich Observatory, *Tent 1919*	51 28.6 N	00 00	Apr 5, 19	....	....	11.1,12.0	66 53.1 N	....	....	......	177.2X[1]	FB
			Apr 6, 19	15.4,15.6	14 28.4 W	....	....	....	....	13	....	FB
			Apr 6, 19	16.0,16.2,16.5	14 27.8 W	....	....	....	....	13	....	FB
			Apr 7, 19	9.4, 9.6	14 21.0 W	8.6	66 51.7 N	....	....	13	177.2X[1]	FB
Kew Observatory, O_m	51 28.1 N	359 41	Aug 9, 15	14.4,14.6,15.0	15 24.5 W	....	....	10.1,11.1	.18428	26	....	EK
			Aug 9, 15	15.2,15.8,16.2	15 21.6 W	....	....	11.8,12.6	.18432	26	....	EK
			Aug 10, 15	10.3,12.4	15 19.8 W	....	....	10.8,11.9	.18426	26	....	EK
			Aug 10, 15	12.8,14.4	15 24.6 W	....	....	13.2,14.1	.18438	26	....	EK
			Oct 13, 15	13.9 to 15.4 (6)	15 20.6 W	....	....	....	....	26	....	EK
			Oct 14, 15	....	....	....	....	10.4,11.2	.18430	26	....	EK
			Oct 14, 15	....	....	....	....	11.8,12.6	.18435	26	....	EK
Kew Observatory, O_w	51 28.1 N	359 41	Aug 25, 15	....	....	13.0 to 16.6 (10)	66 55.7 N	....	....	......	EI 26	EK
			Oct 7, 15	....	....	14.8 (5)	66 56.0 N	....	....	......	EI 26	EK
Kew Observatory, N_e	51 28.1 N	359 41	Apr 1, 19	....	....	14.2	66 57.2 N	....	....	......	177.4X	FB
			Apr 2, 19	....	....	9.8	66 58.2 N	....	....	......	177.4X	FB
			Apr 2, 19	....	....	13.8,14.8	66 57.4 N	....	....	......	177.2X[2]	FB
			Apr 3, 19	....	....	13.6	66 57.0 N	....	....	......	177.2X[2]	FB
Kew Observatory, N_m	51 28.1 N	359 41	Aug 6, 15	14.8 to 16.8 (6)	15 20.7 W	....	....	....	....	26	....	EK
			Aug 11, 15	11.7,13.8	15 24.8 W	....	....	12.3,13.4	.18438	26	....	EK
			Aug 12, 15	....	....	....	....	10.2,10.9	.18426	26	....	EK
			Aug 12, 15	....	....	....	....	11.5,12.2	.18433	26	....	EK
			Aug 12, 15	....	....	....	....	14.3,15.1	.18448	26	....	EK
			Oct 6, 15	14.3 to 15.9 (6)	15 19.5 W	....	....	....	....	26	....	EK
			Oct 7, 15	....	....	....	....	10.5,11.3	.18442	26	....	EK
			Oct 7, 15	....	....	....	....	11.9,12.6	.18444	26	....	EK
			Apr 2, 19	11.4,12.9,16.8	14 48.0 W	....	....	12.0,16.8[3]	.18394	13	....	FB
			Apr 3, 19	8.4,11.0	14 39.9 W	....	....	8.9,10.6	.18383	13	....	FB
			Apr 3, 19	11,8,16.9	14 46.4 W	....	....	12.3,16.4	.18398	13	....	FB
Kew Observatory, N_w	51 28.1 N	359 41	Aug 26, 15	....	....	14.9 to 17.0 (6)	66 57.4 N	....	....	......	EI 26	EK
			Oct 14, 15	....	....	14.1 to 15.6 (6)	66 57.6 N	....	....	......	EI 26	EK
			Apr 3, 19	....	....	14.7	66 56.6 N	....	....	......	177.2X[2]	FB
			Apr 4, 19	....	....	13.6,14.6	66 58.6 N	....	....	......	177.2X[2]	FB

[1] 13X and 14X only. [2] 13X and 16X only. [3] Weight 2.

EUROPE.

NORWAY.

Station	Latitude	Long East of Gr	Date	Declination: Local Mean Time	Declination: Value	Inclination: L M T	Inclination: Value	Hor Intensity: L M T	Hor Intensity: Value	Instruments: Mag'r	Instruments: Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g s			
Skibnoes Fiord	70 44 3 N	23 23	Jul 20, '14	8 6,10 3	1 25 0 W	10 9,11 2	77 04 4 N	9 1, 9 8	11648	25	EI 25	C III
Melko Island	70 41 2 N	23 35	Jul 21, 14	1 1, 2 6	1 30 6 W	3 9	77 01 6 N	1 5, 2 2	11708	25	EI 25	C III
			Jul 21, 14			5 0, 5 3	77 01 0 N				EI 25	C III
Hammerfest, *A*	70 40 3 N	23 40	Jul 7, 14	13 9,16 4	1 38 7 W			14 6,15 9	11771	25		C III
			Jul 8, 14	9 2,11 6	1 30 0 W			9 7,10 9	11676	25		C III
			Jul 8, 14	12 0,14 4	1 35 5 W			12 4,14 0	11696	25		C III
			Jul 8, 14	14 8,16 5	1 36 0 W			15 1,16 0	11710	5		C III
			Jul 9, 14	9 5,11 7	1 31 5 W			10 1,11 3	11687	5		C III
			Jul 9, 14	12 2,15 0	1 37 7 W			12 8,14 5	11730	5		C III
			Jul 10, 14	20 5 to 21 1 (dv)	1 36 0 W	10 8 to						
						14 6 (11)	76 56 5 N			25	EI 3	C III
			Jul 10, 14			15 4 to						
						17 8 (10)	77 00 9 N				EI 25	C III
			Jul 15, 14	19 1 to								
			Jul 16, 14	19 2 (dv)	1 31 6 W					25		C III
			Jul 20, 14			11 9 to						
						21 8 (10)	76 58.1 N				EI 3	C III
			Jul 21, 14			0 8 to						
						5 6 (5)	76 59 7 N				EI 3	C III
			Jul 23, 14	9 4,11 2,11 6	1 32 5 W			9 8,10 9	11688	5		C III
			Jul 23, 14	14 6,14 8,16 5	1 37 2 W			11 9,14 2	11695	5		C III
			Jul 23, 14					15 2,16 1	11736	5		C III
Hammerfest, *B*	70 40 3 N	23 40	Jul 7, 14	13 9,16 4	1 44 4 W			14 6,15 9	11759	5		C III
			Jul 8, 14	11 6	1 37 6 W			9 7,10 9	11669	5		C III
			Jul 8, 14	12 0,14 4	1 41 4 W			12 4,14 0	11686	5		C III
			Jul 8, 14	14 8,16 5	1 42 0 W			15 1,16 0	11702	25		C III
			Jul 9, 14	9 5,11 7	1 36 0 W			10 1,11 3	11680	25		C III
			Jul 9, 14	12 2,15 0	1 42 2 W			12 8,14 5	11719	25		C III
			Jul 10, 14			10 7 to						
						14 6 (11)	76 58 1 N				EI 25	C III
			Jul 10, 14			15 4 to						
						17 8 (10)	77 00 0 N				EI 3	C III
			Jul 11, 14	3 4 to 8 8 (dv)	1 29 6 W	10 0 (4)	77 02 1 N	11 0,12 0	11670	25	EI 25	C III
			Jul 11, 14			12 8 (3)	77 02 5 N	15 2,16 3	11699	25	EI 25	C III
			Jul 11, 14			14 4 (4)	77 01 6 N				EI 25	C III
			Jul 11, 14			17 2 (4)	77 01 1 N				EI 25	C III
			Jul 13, 14			9 2,9 4	77 03.5 N				EI 25	C III
			Jul 13, 14			11 7 (4)	77 03 8 N	10 2 to				
								15 9 (6)	11680	25	EI 25	C III
			Jul 13, 14			14 4 (4)	77 03 1 N				EI 25	C III
			Jul 13, 14			16 3,16 5	77 01 6 N				EI 25	C III
			Jul 14, 14	9 4 to 16 9 (8)	1 40 2 W			9 9 to				
								16 6 (8)	11695	25		C III
			Jul 15, 14	9 0,10.8	1 36 0 W			9 4,10 4	11668	25		C III
			Jul 15, 14	11 0,12 9,13 8	1 40.4 W			11 3,12 5	11671	25		C III
			Jul 17, 14	9 5 to 18 4 (8)	1 42.8 W			9 9 to				
								18 0 (8)	11694	25		C III
			Jul 17, 14	18 5 to 20 8 (dv)	1 43 8 W					25		C III
			Jul 20, 14	8 6 to				9 0 to				
			Jul 21, 14	5 5 (22)	1 39.1 W			6 0(19)	11701	5		C III
			Jul 23, 14	9 4,11 2	1 35 9 W			9 8,10 8	11680	25		C III
			Jul 23, 14	11 6,14 6	1 41.0 W			11 9,14 2	11684	25		C III
			Jul 23, 14	14 8,16 5	1 41 4 W			15 2,16 1	11719	25		C III
Hammerfest, *Meridianstötten*	70 40 2 N	23 40	Jul 6, 14	10 0,12 1,12 9	1 26 4 W	14 9 (3)	76 53 5 N	10 6,11 7	11753	25	EI 25	C III
Haaien Island	70 39 7 N	23 28	Jul 20, 14	18 6,20 9,21 1	1 52 9 W	22 2,22 6	77 00 8 N	20 0,20 6	11798	25	EI 25	C III
Hielmen Island	70 39 3 N	23 19	Jul 20, 14	14 4,16 0	1 57 8 W	16 7 (3)	76 54 3 N	15 1,15 7	11757	25	EI 25	C III

RUSSIA

Station	Latitude	Long East of Gr	Date	Declination: Local Mean Time	Declination: Value	Inclination: L M T	Inclination: Value	Hor Intensity: L M T	Hor Intensity: Value	Instruments: Mag'r	Instruments: Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c g s			
Vaigach	69 41 5 N	60 12	Aug 12, 18	15 0,18 1	20 07.8 E			16 0,17 4	10912	8		RA
			Aug 13, 18	10 1	20 25.4 E	12 0	78 40 8 N	12 2	10878	*205*	205 123	RA
Khabarowa	69 39 8 N	60 24	Aug 15, 18	11 6,14 4	19 56.8 E	17 6	78 37 4 N	12 5,13 9	10910	8	205 123	RA
			Aug 15, 18	16 6	19 50 0 E			17 6	10941	*205*		RA

NORTH AMERICA.

CANADA.

Station	Latitude	Long. East of Gr.	Date	Declination		Inclination		Hor. Intensity		Instruments		Obs'r
				Local Mean Time	Value	L. M. T.	Value	L. M. T.	Value	Mag'r	Dip Circle	
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Coats Island	62 37.2 N	277 47	Sep 19, '14	12.7,14.1	39 33.6 W	13.4	86 29.4 N	13.4	.03731	4655	4655.(12)	P&B
Erik Cove	62 33.2 N	282 35	Sep 1, 14	5.6	42 38.4 W	17.8	84 35.0 N	18.4	.05830	4655	4655.(12)	DWB
Ashe Inlet, *A*	62 32.8 N	289 25	Aug 27, 14	10.0,13.1	52 02.6 W	14.2	83 40.5 N	11.6,12.6	.06698	13	4655.(12)	P&B
Ashe Inlet, *B*	62 32.8 N	289 25	Aug 27, 14	9.6	51 10.7 W	11.0	83 45.6 N	11.0	.06523	4655	4655.(12)	WJP
Eskimo Point	61 09.8 N	266 08	Sep 13, 14	9.4,11.9	5 19.8 E	13.0	85 57.8 N	10.0,11.2	.04480	13	4655.(12)	P&B
			Sep 13, 14	....	....	14.6	85 56.5 N	14.5	.04489	169	169.567	P&B
Smith Island	60 44.2 N	281 21	Sep 3, 14	11.9,13.1	38 20.7 W	15.5	84 37.8 N	12.5,13.5	.05728	13	4655.(12)	DWB
			Sep 3, 14	....	....	....	....	15.5	.05734	4655	....	DWB
Mistake Bay	59 12.6 N	281 49	Sep 6, 14	8.3,10.7	33 35.7 W	11.8	83 57.9 N	8.9,10.1	.06448	13	4655.(12)	P&B
			Sep 6, 14	14.4	33 47.4 W	16.0	83 58.8 N	16.0	.06385	169	169.7	P&B
Sydney	46 08.8 N	299 48	Nov 11, 14	14.3,15.9	25 55.2 W	16.8	74 12.1 N	14.8,15.5	.15644	13	169.56	P&B
			Nov 11, 14	16.3	25 48.5 W	....	....	....	....	169	....	P&B

CENTRAL AMERICA.

Station	Latitude	Long. East of Gr.	Date	Decl. Local Mean Time	Decl. Value	Incl. L. M. T.	Incl. Value	Hor. Int. L. M. T.	Hor. Int. Value	Mag'r	Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Colon, *Washington Hotel*	9 22.0 N	280 05	Mar 27, '15	11.9,14.5	4 45.9 E	....	....	13.0,13.9	.32328	21	....	C IV
			Mar 28, 15	....	....	9.0	36 02.4 N	....	....	......	21.(133)4)	C IV
			Oct 11, 16	11.4,13.4	4 50.2 E	....	....	11.9,12.9	.32194	21	....	W&S
			Oct 12, 16	....	....	8.9	36 19.7 N	....	....	......	21.(13(6)	W&S
Colon, *Sweetwater, A*	9 21.3 N	280 03	Mar 27. 15	13.5 to 14.8 (6)	4 58.8 E	....	....	....	....	5	....	C IV
			Mar 27, 15	15.2 to 16.5 (6)	4 59.1 E	....	....	....	....	25	....	C IV
			Mar 29, 15	....	....	....	....	8.8, 9.8	.32200	25	....	C IV
			Mar 29, 15	....	....	....	....	10.6,11.6	.32216	25	....	C IV
			Mar 29, 15	....	....	....	....	13.0,14.0	.32196	5	....	C IV
			Mar 29, 15	....	....	....	....	15.1,16.0	.32172	5	....	C IV
			Mar 31, 15	....	....	13.0 to 14.8 (6)	36 01.7 N	....	....	......	EI 3	C IV
			Mar 31, 15	....	....	15.2 to 16.2 (6)	36 02.0 N	....	....	......	EI 25	C IV
			Apr 1, 15	....	....	10.1 to 16.2 (8)	36 01.7 N	10.8 to 15.5 (6)	.32187	25	EI 25	C IV
			Apr 2, 15	....	....	9.0 to 16.6 (12)	36 01.8 N	13.6,14.4	.32176	25	EI 25	C IV
			Apr 2, 15	....	....	....	....	15.2,16.2	.32156	25	....	C IV
			Oct 10, 16	9.8,11.4	5 05.8 E	15.5	36 23.4 N	10.2,11.1	.32065	21	21.(13(6)	W&S
Colon, *Sweetwater, B*	9 21.3 N	280 03	Mar 27, 15	13.5 to 14.8 (6)	4 59.0 E	....	....	....	....	25	....	C IV
			Mar 27, 15	15.2 to 16.5 (6)	5 00.3 E	....	....	....	....	5	....	C IV
			Mar 29, 15	....	....	....	....	8.8, 9.9	.32226	5	....	C IV
			Mar 29, 15	....	....	....	....	10.6,11.6	.32217	5	....	C IV
			Mar 29, 15	....	....	....	....	13.0,14.0	.32212	25	....	C IV
			Mar 29, 15	....	....	....	....	15.1,16.0	.32180	25	....	C IV
			Mar 30, 15	....	....	....	....	9.7 to 14.8 (5)	.32215	5	....	C IV
			Mar 31, 15	....	....	13.0 to 14.8 (6)	36 00.5 N	....	....	......	EI 25	C IV
			Mar 31, 15	....	....	15.2 to 16.2 (6)	36 00.9 N	....	....	......	EI 3	C IV
			Apr 5, 15	15.4 to 17.2 (dv)	4 58.8 E	....	....	....	....	5	....	C IV
			Apr 6, 15	7.7 to 9.0 (dv)	5 00.5 E	....	....	....	....	5	....	C IV
			Apr 6, 15	10.8 to 14.2 (4)	4 59.2 E	....	....	....	....	5	....	C IV
Cristobal, *A*	9 20.7 N	280 06	May 4, 18	....	....	11.2 to 14.7 (12)	36 38.2 N	....	....	......	EI 25	C V
			May 4, 18	....	....	15.4 to 17.0 (8)	36 37.5 N	....	....	......	EI 3	C V
			May 6, 18	....	....	9.4, 9.6	36 35.0 N	....	....	......	EI 3	C V
			May 6, 18	....	....	9.8,10.0	36 35.2 N	....	....	......	EI 3	C V
			May 8, 18	....	....	....	....	10.8 to 16.6 (8)	.32107	25	....	C V
Cristobal, *B*	9 20.7 N	280 06	May 4, 18	....	....	11.2 to 14.7 (12)	36 38.7 N	....	....	......	EI 3	C V
			May 4, 18	....	....	15.4 to 17.0 (8)	36 40.6 N	....	....	......	EI 25	C V
			May 6, 18	....	....	9.3 to 16.0 (12)	36 38.0 N	12.1,14.8	.32122	25	EI 25	C V
			May 7, 18	....	....	10.5 (4)	36 35.2 N	10.3 to 17.2 (7)	.32145	25	EI 25	C V
			May 8, 18	....	....	....	....	9.0, 9.8	.32165	25	....	C V

NORTH AMERICA.

NEWFOUNDLAND (INCLUDING LABRADOR COAST).

Station	Latitude	Long. East of Gr.	Date	Declination: Local Mean Time	Declination: Value	Inclination: L. M. T.	Inclination: Value	Hor. Intensity: L. M. T.	Hor. Intensity: Value	Instruments: Mag'r	Instruments: Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Port Burwell, *A*	60 24.8 N	295 08	Aug 21, '14	14.2	45 54.4 W	....	....	....	....	*4655*	....	P&B
			Aug 22, 14	9.2	46 17.1 W	10.7	82 02.0 N	11.9,13.4	.08314	13	4655.(12)	P&B
			Aug 22, 14	10.1	46 13.8 W	....	....	....	....	*4655*	....	P&B
Port Burwell, *B*	60 24.8 N	295 08	Aug 21, 14	4.0 to 9.3 (dv)	41 31.0 W	15.6	81 48.8 N	12.6,13.7	.08622	13	4655.(12)	P&B
			Aug 21, 14	15.0	41 22.9 W	....	....	....	....	*4655*	....	P&B
Sangmijok	59 59.0 N	295 48	Aug 19, 14	....	....	15.5	81 39.2 N	15.6	*.08636*	*4655*	4655.(12)	P&B
Hopedale	55 27.1 N	299 48	Aug 9, 14	5.8	38 42.2 W	6.8	78 47.4 N	6.8	*.11370*	*4655*	4655.(12)	P&B
Gready*	53 48.2 N	303 35	Aug 4, 14	12.6,13.0	36 42.3 W	14.9	76 49 N	15.3	*.1352*	*4655*	4655.(12)	P&B
Domino	53 28.4 N	304 14	Aug 2, 14	16.8	46 05.6 W	15.6	79 51.4 N	17.5	.10481	13	4655.(12)	P&B
Boulter Rock, *A*	53 06.2 N	304 14	Jul 31, 14	18.0	38 16 W	....	....	....	....	3578[1]	....	WJP
Boulter Rock, *B*	53 06.2 N	304 14	Jul 31, 14	....	....	18.1	76 44.2 N	18.1	*.13106*	*4655*	4655.(12)	DWB
Gull Rocks, *A*	52 18.7 N	304 20	Jul 18, 14	12.0	36 17.4 W	12.9	76 18.8 N	12.9	*.13451*	*4655*	4655.(12)	P&B
Gull Rocks, *B*	52 18.7 N	304 20	Oct 15, 14	13.9,14.4	36 09.8 W	....	....	....	....	*169*	....	P&B
Green Island	52 17.8 N	304 20	Oct 15, 14	10.7,12.0	35 38.8 W	11.3	76 04.6 N	11.3	*.13719*	*169*	169.567	WJP
Great Island	52 17.4 N	304 24	Oct 17, 14	9.3,11.0	37 23.4 W	10.1	76 19.9 N	10.2	*.13425*	*169*	169.567	WJP
Battle Harbor, *C*	52 16.4 N	304 25	Jun 30, 14	19.0,19.2	34 50.6 W	....	....	....	....	13	....	P&B
			Jul 1, 14	5.6, 6.1	34 53.4 W	....	....	9.1,10.7	.13542	13	....	P&B
			Jul 2, 14	9.9	34 49.5 W	15.1	76 07.8 N	15.0	*.13544*	*169*	169.567	P&B
			Jul 3, 14	....	....	9.6,11.3	76 10.7 N	9.3,11.1	*.13480*	*169*	169.567	P&B
			Jul 3, 14	....	....	14.9,16.7	76 07.4 N	14.9,16.7	*.13527*	*4655*	4655.(127)	P&B
			Jul 7, 14	10.6	34 54.0 W	9.5	76 09.7 N	9.5	*.13491*	*4655*	4655.(127)	P&B
			Oct 9, 14	7.5 to 10.0 (5)	34 53.2 W	....	....	....	....	13	....	P&B
			Oct 9, 14	15.4,15.8,16.6	34 56.2 W	....	....	....	....	13	....	P&B
			Oct 10, 14	7.5, 7.7	34 58.8 W	....	....	....	....	13	....	P&B
			Oct 13, 14	14.8	34 57.0 W	....	....	....	....	*4655*	....	P&B
			Oct 14, 14	15.0	34 58.9 W	16.2	76 08.3 N	16.0	*.13532*	*4655*	4655.(127)	P&B
			Oct 16, 14	9.5	34 52.7 W	10.8	76 09.2 N	10.8	*.13457*	*4655*	4655.(127)	P&B
			Oct 19, 14	14.0	34 52.9 W	15.0	76 08.8 N	15.0	*.13477*	*4655*	4655.(127)	P&B
			Oct 20, 14	7.1, 7.4, 7.8	34 51.2 W	10.1,11.8	76 10.5 N	10.0,11.8	*.13462*	*169*	169.567	P&B
			Oct 20, 14	....	....	14.9	76 06.8 N	14.9	*.13555*	*169*	169.567	P&B
Battle Harbor, *D*	52 16.4 N	304 25	Jul 1, 14	....	....	....	....	14.4,15.8	.13552	13	....	P&B
			Jul 2, 14	9.9	34 52.0 W	15.1	76 06.8 N	15.1	*.13534*	*4655*	4655.(127)	P&B
			Jul 3, 14	7.1	34 48.8 W	9.4,11.4	76 11.1 N	9.4,11.4	*.13489*	*4655*	4655.(127)	P&B
			Jul 3, 14	....	....	15.0,16.6	76 09.2 N	15.1,16.7	*.13518*	*169*	169.567	P&B
			Jul 7, 11	10.7	34 57.8 W	9.6	76 11.3 N	9.6	*.13503*	*169*	169.567	P&B
			Oct 14, 14	15.0	35 04.6 W	16.2	76 08.5 N	16.2	*.13503*	*169*	169.567	P&B
			Oct. 16, 14	9.6	34 51.3 W	10.8	76 09.3 N	10.8	*.13473*	*169*	169.567	P&B
			Oct 19, 14	14.0	34 56.0 W	15.0	76 11.3 N	15.0	*.13459*	*169*	169.567	P&B
			Oct 20, 14	7.1, 7.4, 7.8	34 47.3 W	10.1,11.8	76 10.3 N	10.0,11.8	*.13494*	*4655*	4655.(127)	P&B
			Oct 20, 14	....	....	14.9	76 08.6 N	14.9	*.13513*	*4655*	4655.(127)	P&B
Battle Harbor, *E*	52 16.4 N	304 25	Oct 23, 14	14.5	34 23.5 W	15.0	76 10.3 N	15.0	*.13488*	*4655*	4655.(7)	DWB
Battle Harbor, *F**	52 16.4 N	304 25	Oct 23, 14	14.5	32 52.0 W	15.0	76 37.6 N	15.0	*.13077*	*169*	169.7	WJP
Battle Harbor, *G*	52 16.4 N	304 25	Oct 23, 14	15.7	34 43.6 W	16.1	76 09.6 N	16.1	*.13498*	*4655*	4655.(7)	DWB
Battle Harbor, *H*	52 16.4 N	304 25	Oct 23, 14	15.7	34 40.4 W	16.1	76 11.0 N	16.1	*.13459*	*169*	169.7	WJP
Battle Harbor, *I*	52 16.1 N	304 25	Oct 26, 14	9.5	36 10.6 W	10.0	76 09.9 N	10.0	*.13448*	*169*	169.7	WJP
Battle Harbor, *J*	52 16.1 N	304 25	Oct 26, 14	11.2	36 07.3 W	12.2	76 21.0 N	12.2	*.13364*	*169*	169.7	WJP
Battle Harbor, *K*	52 16.1 N	304 25	Oct 26, 14	9.5	38 07.1 W	10.0	76 00.3 N	10.0	*.13882*	*4655*	4655.(7)	DWB
Battle Harbor, *L**	52 16.1 N	304 25	Oct 26, 14	10.6	34 50.7 W	13.0	77 00.0 N	....	....	*4655*	169.7	P&B
			Oct 26, 14	....	....	....	....	13.0	*.12768*	*169*	....	P&B
Battle Harbor, *M*	52 15.4 N	304 22	Oct 24, 14	13.2	35 48.0 W	13.4	76 13.8 N	13.4	*.13957*	*169*	169.7	P&B
Battle Harbor, *N*	52 15.3 N	304 23	Oct 24, 14	14.0	34 44.9 W	14.3	76 11.1 N	14.3	*.13513*	*169*	169.7	P&B
Bay of Islands	48 57 N	302 00	Nov. 3, 14	10.8,12.6	30 38.9 W	14.2	75 10.2 N	11.3,12.1	.14734	13	169.567	P&B
			Nov 3, 14	13.1	30 36.4 W	....	....	14.2	*.14661*	*169*	....	P&B

UNITED STATES.

Station	Latitude	Long. East of Gr.	Date	Declination: Local Mean Time	Declination: Value	Inclination: L. M. T.	Inclination: Value	Hor. Intensity: L. M. T.	Hor. Intensity: Value	Instruments: Mag'r	Instruments: Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Dutch Harbor, *A**	53 54.2 N	193 28	Jul 22, '15	15.4,18.0	16 08.4 E	....	....	16.0,17.5	.20786	25	....	C IV
			Jul 23, 15	14.1,17.0	16 07.7 E	....	....	14.5,16.6	.20772	25	....	C IV
			Jul 24, 15	8.6,11.2	16 16.2 E	....	....	9.0,10.8	.20772	25	....	C IV
			Jul 24, 15	11.7	16 12.4 E	....	....	13.6,14.6	.20774	5	....	C IV
			Jul 24, 15	15.4,15.5,16.6	16 09.5 E	....	....	....	....	5	....	C IV
			Jul 26, 15	8.5,10.4,10.8	16 13.9 E	....	....	8.9 to 17.3 (8)	.20785	5	....	C IV
			Jul 26, 15	13.5 to 16.2 (4)	16 07.3 E	....	....			5	....	C IV
			Jul 27, 15	8.5,10.0,11.5	16 15.9 E	....	....	8.8, 9.5	.20771	5	....	C IV
			Jul 27, 15	....	....	....	....	10.3,11.1	.20754	5	....	C IV
			Jul 27, 15	13.7 to 18.5 (dv)	16 09.5 E	....	....	....	....	25	....	C IV

* Local disturbance. [1] Berger and Son theodolite.

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UNITED STATES—*Continued.*

Station	Latitude	Long. East of Gr.	Date	Declination Local Mean Time	Declination Value	Inclination L. M. T.	Inclination Value	Hor. Intensity L. M. T.	Hor. Intensity Value	Instruments Mag'r	Instruments Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Dutch Harbor, *A*—Concluded*	53 54.2 N	193 28	Jul 28, '15			10.6 to 15.8 (12)	66 32.4 N				EI 25	C IV
			Jul 28, 15			16.7 (4)	66 32.4 N				EI 3	C IV
			Jul 29, 15			8.3 to 10.8 (9)	66 31.8 N				EI 3	C IV
			Jul 29, 15			13.4,13.8	66 32.8 N	14.4,15.6	.20767	25	EI 25	C IV
			Jul 29, 15			16.3,16.6	66 31.4 N				EI 25	C IV
			Jul 30, 15			8.2 to 17.6 (10)	66 32.3 N	9.1 to 17.2 (8)	.20772	25	EI 25	C IV
			Jul 31, 15					9.0	.20785	25		C IV
			Jul 31, 15	10.4,11.8	16 12.7 E	8.3, 8.6	66 31.7 N	10.8,11.4	.20776	25	EI 25	C IV
			Jul 31, 15			9.9,10.1	66 31.1 N				EI 25	C IV
Dutch Harbor, *B**	53 54.2 N	193 28	Jul 22, 15	15.4,18.0	16 28.0 E			16.1,17.5	.20932	5		C IV
			Jul 23, 15	14.1,17.0	16 26.6 E			14.5,16.6	.20928	5		C IV
			Jul 24, 15	8.6,11.2	16 35.6 E			9.1,10.8	.20922	5		C IV
			Jul 24, 15	11.7	16 31.0 E			13.6,14.7	.20919	25		C IV
			Jul 26, 15	8.5,10.4,10.8	16 33.2 E			8.9,10.0	.20934	25		C IV
			Jul 26, 15	13.5,13.8	16 26.1 E			11.2,12.1	.20923	25		C IV
			Jul 28, 15			10.6 to 15.8 (12)	66 16.4 N				EI 3	C IV
			Jul 28, 15			16.7 (4)	66 17.1 N				EI 25	C IV
			Jul 29, 15			8.3 to 10.8 (9)	66 16.5 N				EI 25	C IV
Dutch Harbor, *C. & G. S.**	53 53.4 N	193 28	Jul 26, 15	15.9,18.4	17 16.0 E			16.7,17.8	.20926	25		C IV
			Jul 27, 15			9.8	66 31.8 N				189.1256	C IV
Goldendale, *C. & G. S., 1914**	45 50.0 N	239 10	Jun 5, 18	10.2,12.4	22 59.0 E	8.7, 9.2	69 27.4 N	10.8,11.9	.20427	26	EI 26	F&E
Goldendale, *A**	45 50.0 N	239 10	Jun 5, 18	17.3,18.3	23 19.6 E	16.6	69 28.9 N			26	EI 26	F&E
			Jun 6, 18	11.1	23 18.1 E					26		F&E
			Jun 6, 18	18.6	23 18.2 E			19.0	.20067	13		F&E
			Jun 7, 18	9.7 to 15.3 (dv)	23 18.3 E					13		CCE
			Jun 8, 18	10.9 to 17.4 (dv)	23 16.6 E					13		CCE
			Jun 9, 18	10.8,14.4	23 18.4 E			12.3,13.9	.20079	13		F&E
			Jun 10, 18	8.4 to 12.7 (dv)	23 22.0 E					13		CCE
Goldendale, *B**	45 50.0 N	239 10	Jun 7, 18			10.1	69 36.5 N				EI 26	HWF
			Jun 8, 18			10.1,17.6	69 36.9 N				EI 26	HWF
Woburn	42 29.6 N	288 52	Jun 7, 18	15.8 to 19.4 (dv)	13 24.7 W					68		GLH
			Jun 8, 18	13.8 to 20.5 (dv)	13 28.2 W					68		GLH
			Jun 9, 18	14.1 to 18.8 (dv)	13 28.3 W					68		GLH
New London, *C. & G. S., 1904*	41 21.0 N	287 53	Oct 14, 17	12.2,14.0	12 14.9 W	15.6,16.0	72 46.6 N	12.7,13.8	.17410	26	EI 26	P&A
			Mar 19, 18	14.3,17.5	12 16.4 W	15.4,16.5	72 48 N			*169*	169.567	JPA
Griswold Landing, *A*	41 19.5 N	287 55	Oct 25, 17	12.2,13.8	11 46.6 W			12.7,13.5	.17555	26		P&A
Pine Island	41 18.7 N	287 56	Oct 20, 17	10.2,11.2	12 20.5 W	11.8	72 40.8 N	10 5,10.9	.17543	26	EI 26	P&A
Ocean Beach	41 18.2 N	287 54	Oct 15, 17	12.4,14.2	11 59.7 W	15.1,15.3	72 31.4 N	12.9,13.8	.17730	26	EI 26	P&A
Fishers Island	41 15.5 N	287 58	Oct 18, 17	12.2,13.3	11 53.9 W	13.9	72 30.5 N	12.5,13.0	.17604	26	EI 26	P&A
Great Gull Island	41 12.2 N	287 53	Oct 19, 17	11.8,12.9	12 41.8 W	13.7	72 27.9 N	12.2,12.6	.17642	26	EI 26	P&A
Greenport, *A*	41 06.4 N	287 38	Oct 13, 14	9.5,11.0	11 21.0 W	11.3	72 13.0 N	9.9,10.5	.18042	25	EI 25	C III
			Oct 13, 14	13.6,14.7	11 24.1 W	15.1,15.3	72 13.6 N	13.8,14.4	.18048	25	EI 25	C III
Derring Harbor	41 05 N	287 39	Oct 14, 14	11.7,12.8	11 42.6 W	11.2,13.6	72 20.7 N	12.0,12.5	.17948	25	EI 25	C III
			Oct 14, 14	13.9,14.9	11 43.5 W	15.3,16.4	72 19.8 N	14.2,14.6	.17959	25	EI 25	C III
Corona	39 57 N	254 18	Jun 7, 18	12.0 to 18.2 (dv)	15 42.6 E					14		B,S,E
			Jun 8, 18	10.6 to 18.3 (dv)	15 43.3 E					14		B,S,E
			Jun 9, 18	8.0	15 55.9 E	11.2	67 32.5 N	9.2	.22144	14	14.15	LAB
Woodland Park	38 59.2 N	254 57	Jun 18, 18	13.5,14.9	14 20.8 E	11.2	66 58.7 N	13.9,14.6	.22462	26	EI 26	F&E
			1914									
Washington, S. M. O., N_m[1]	38 57.4 N	282 56	Sep 16,17	9.4–15.1 (6)	4 34.1 W			9.9–14.6	.19079	3		CWH
			Sep 18			12.8–16.4	70 59.2 N				EI 48	CWH
			Nov 2,3,4			9.0–16.0	71 00.2 N				EI 48	HFJ
			Nov 7,9	9.7–16.3 (7)	4 33.2 W			10.2–15.1	.19066	3		HFJ
			Nov 16,17	11.7–16.2 (6)	4 33.4 W			10.8–15.5	.19068	3		HFJ
			Nov 18,23	Various	4 32.9 W					3		E&J
			Dec 2	14.5–15.7 (6)	4 33.0 W					3		IAL
			1915									
			Feb 2,3,4	9.3–16.0 (13)	4 33.7 W			9.8–15.5	.19052	3		HMH
			Feb 9	14.6–17.1 (dv)	4 34.9 W					3		HMH
			Feb 10	7.6–16.6 (dv)	4 32.4 W					3		HMH
			Mar 4,5,6	9.5–16.3 (11)	4 35.1 W					3		F&K
			Mar 8,9	9.1–16.0 (9)	4 34.6 W			10.7–14.8	.19024	3		HWH
			Mar 10,11	8.8–16.2 (dv)	4 34.3 W					3		F&K
			Mar 16			11.6–15.4	71 00.5 N				EI 48	HWH
			Apr 22,23, 24					10.1–15.5	.19032	3		HWH
			Apr 23,24	9.3–16.0 (9)	4 36.2 W					3		HWH
			Jun 8, 9	9.3–16.6 (6)	4 36.2 W			9.8–16.2	.19039	3		EK

* Local disturbance.

[1] Where several days are grouped in the date column with but single entries of magnetic elements, the values given are the means of determinations made between approximately the same local mean times on each day.

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UNITED STATES—*Continued.*

Station	Latitude	Long. East of Gr.	Date	Declination: Local Mean Time	Declination: Value	Inclination: L. M. T.	Inclination: Value	Hor. Intensity: L. M. T.	Hor. Intensity: Value	Instruments: Mag'r	Instruments: Dip Circle	Obs'r
	° ′	° ′		h h	° ′	h h	° ′	h h	c. g. s.			
Washington, S. M. O., N_m —*Continued*[1]	38 57.4 N	282 56	*1915*									
			Jun 14, 15, 16	9.3–12.6 (6)	4 34.3 W			10.1–11.8	.19007	3		EK
			Jun 16			14.0–15.6	71 00.5 N				EI 48	EK
			Jun 25, 26, 28	11.3–16.0 (6)	4 37.6 W			9.5–14.7	.19018	3		EK
			Jul 12, 13, 14	9.1–16.0 (6)	4 37.2 W					3		EK
			Jul 13, 14					9.6–15.5	.19006	3		EK
			Sep 13, 14	10.0–15.3 (6)	4 38.8 W			9.4–15.4	.18990	3		HRS
			Sep 15, 16	9.6–15.0 (6)	4 36.5 W			9.3–15.5	.18988	3		HRS
			Sep 27, 28	9.6–15.8 (6)	4 37.7 W			10.3–15.2	.18975	3		ADP
			Oct 23, 25, 26	9.5–16.0 (9)	4 40.9 W			10.1–15.4	.18949	3		HRS
			Nov 4, 5	9.7–16.1 (6)	4 35.9 W					3		HWF
			Nov 20, 22, 23	9.4–15.9 (14)	4 37.2 W			10.8–16.2	.18966	3		HWF
			Nov 24, 26	9.7–16.3 (22)	4 38.5 W					3		HWF
			1916									
			Feb 25, 26	10.8–15.6 (4)	4 38.1 W			9.9–16.2	.18970	3		WFW
			Mar 1, 2	10.4–15.6 (6)	4 36.2 W			9.6–16.3	.18969	3		WFW
			Mar 13, 14, 15	10.3–15.0 (6)	4 37.9 W			9.6–15.7	.18948	3		WFW
			Apr 3, 4	9.2–16.8 (6)	4 37.8 W			9.9–16.1	.18941	3		WFW
			Apr 24, 25	9.3–16.0 (6)	4 39.8 W			10.2–15.0	.18936	3		DMW
			Aug 8	14.7–15.9 (3)	4 40.4 W					3		HRS
			Aug 23, 24, 25	11.3–16.0 (6)	4 43.2 W			10.0–16.7	.18910	3		HRS
			Aug 30, 31	9.7–16.3 (5)	4 42.0 W			10.4–15.7	.18920	3		HRS
			Sep 1	12.6	4 47.9 W			12.0	.18909	3		HRS
			Sep 11, 12					10.4–16.4	.18899	3		HRS
			Sep 11, 12, 14	9.3–15.5 (6)	4 43.6 W					3		HRS
			1917									
			Jun 27, 28, 29	9.8–16.4 (8)	4 43.5 W					3		HWF
			Jun 28, 29					11.1–16.1	.18875	3		HWF
			Jul 4	9.2–14.7 (6)	4 41.9 W			9.5–14.3	.18874	3		HWF
			Aug 16, 17, 18					9.8–16.4	.18860	3		JMM
			Aug 17, 18	9.1–17.2 (10)	4 44.1 W					3		JMM
			Oct 22, 23, 24					10.3–15.4	.18829	3		AT
			Oct 22, 24, 25	9.9–15.6 (6)	4 42.4 W					3		AT
			Nov 2, 3, 5, 6	11.5–16.5 (6)	4 42.3 W					3		AT
			Nov 14, 15	10.3–15.2 (6)	4 42.5 W			10.6–15.4	.18823	3		AT
			Dec 5					13.4–16.2	.18827	3		AT
			Dec 5, 6	10.5–16.4 (6)	4 40.6 W					3		AT
			Dec 7, 8					10.9–16.0	.18842	3		AT
			Dec 7, 8, 10	10.4–15.2 (6)	4 41.2 W					3		AT
			1918									
			Feb 14, 15	9.8–16.1 (7)	4 45.5 W			10.3–15.5	.18809	3		DMW
			Mar 14, 15					12.0–16.7	.18833	3		DMW
			Mar 15, 16	10.1–15.3 (6)	4 42.7 W					3		DMW
			Mar 22	12.6–12.9 (2)	4 44.9 W			10.4–11.6	.18782	3		DMW
			Apr 25, 26					9.5–15.0	.18828	3		DMW
			Apr 25, 26, 27	8.8–15.3 (6)	4 44.8 W					3		DMW
			Apr 28, 29	7.5–12.3 (3)	4 40.3 W			8.2–15.6	.18834	3		AT
			Jun 21, 24, 25	9.1–14.6 (6)	4 45.1 W			9.2–13.7	.18823	3		JPA
			Jul 2	13.0–15.2 (dv)	4 44.1 W					3		LLT
			Jul 3	5.2–18.5 (dv)	4 40.4 W					3		LLT
			Jul 13, 15	9.5–15.4 (6)	4 42.7 W			9.3–14.9	.18803	3		DMW
			1919									
			Jan 21, 22					10.1–15.9	.18765	3		HWF
			Jan 21, 22, 24	11.9–16.2 (7)	4 46.3 W					3		HWF
			Feb 12, 13, 14	10.4–15.3 (7)	4 46.3 W			9.9–14.5	.18798	3		HWF
			Mar 1, 3	9.5–16.3 (10)	4 46.6 W					3		HWF

[1] See foot-note 1, p. 71.

NORTH AMERICA.

UNITED STATES—*Continued.*

Station	Latitude	Long. East of Gr.	Date	Declination		Inclination		Hor. Intensity		Instruments		Obs'r
				Local Mean Time	Value	L. M. T.	Value	L. M. T.	Value	Mag'r	Dip Circle	
	° ′	° ′	*1919*	h h	° ′	h h	° ′	h h	c. g. s.			
Washington, S. M. O., N_m —*Concluded*[1]	38 57.4 N	282 56	Jul 31	13.0	4 49.2 W			14.7	.18796	3		F&G
			Aug 1, 2	10.2–15.1 (5)	4 47.1 W			8.8–13.8	.18753	3		F&G
			Sep 2	10.2–13.8 (2)	4 48.6 W			13.3–14.7	.18780	3		W&F
			Sep 19, 20					8.6–15.2	.18688	3		DMW
			Nov 3, 4	13.0–15.9 (6)	4 52.7 W			10.0–15.5	.18719	3		DMW
			1915									
Washington, S. M. O., N_e[1]	38 57.4 N	282 56	Jun 2, 3, 4, 5			9.6–16.1	70 59.4 N				EI 48	EK
			Jun 14, 15			15.0–15.8	70 59.5 N				EI 48	EK
			Jul 1, 2			9.3–15.6	71 01.3 N				EI 48	EK
			Jul 14, 15			9.8–15.8	71 00.6 N				EI 48	EK
			Sep 30			14.0–16.0	71 03.0 N				EI 48	ADP
			Oct 1			10.3–11.4	71 01.9 N				EI 48	ADP
			Oct 28, 29			10.1–15.8	71 03.7 N				EI 48	HWF
			Nov 3, 4			10.1–16.0	71 03.0 N				EI 48	HWF
			Nov 27, 29			10.0–16.1	71 02.3 N				EI 48	HWF
			1916									
			Mar 25, 27			9.5–15.7	71 04.2 N				EI 48	WFW
			Apr 7			11.0–15.3	71 03.4 N				EI 48	WFW
			Apr 10, 11			9.4–15.6	71 03.3 N				EI 48	WFW
			May 11, 12			10.0–13.6	71 03.9 N				EI 48	DMW
			Aug 4, 5, 7			9.9–16.4	71 04.1 N				EI 48	S&S
			Aug 14, 15, 16			10.4–15.3	71 04.2 N				EI 48	S&T
			Aug 19, 21, 26			9.5–16.8	71 04.1 N				EI 48	HRS
			Sep 2, 5, 6, 7			9.8–14.2	71 05.3 N				EI 48	HRS
			Sep 20, 21			10.1–16.1	71 04.0 N				EI 48	HRS
			Oct 17			10.6–13.6	71 05.5 N				EI 48	HWF
			Dec 29			10.5–14.4	71 05.8 N				EI 48	HWF
			1917									
			Jan 6			14.2–16.4	71 06.1 N				EI 48	HWF
			Nov 8, 10			10.8–14.6	71 06.2 N				EI 48	AT
			1918									
			Feb 5, 6			10.7–16.2	71 07.1 N				EI 48	DMW
			Mar 22			9.8–12.2	71 09.2 N				EI 48	DMW
			Apr 28, 29			7.1–16.5	71 06.7 N				EI 48	A,F,T
			Jun 25, 26			8.9–15.3	71 05.5 N				EI 48	JPA
			Jul 18, 19			12.0–15.5	71 06.0 N				EI 48	W&F
			1919									
			Jan 27, 28			10.1–16.0	71 07.5 N				EI 48	HWF
			Feb 18, 19, 20			10.0–16.4	71 07.3 N				EI 48	HWF
			Feb 28			15.0–16.2	71 09.0 N				EI 48	HWF
			Mar 1, 3			9.9–16.5	71 09.3 N				EI 48	HWF
			Jun 23, 24			9.1–14.5	71 08.5 N				EI 48	F&M
			Aug 18			10.0–14.3	71 09.4 N				EI 48	HWF
			Nov 6			9.5–13.5	71 09.6 N				EI 48	DMW
			1915									
Washington, S. M. O., E_m[1]	38 57.4 N	282 56	Dec 1, 2, 3	9.5–14.4 (8)	4 36.6 W			10.6–16.4	.18983	3		HWF
			Dec 4, 6			9.7–16.0	71 03.4 N				EI 48	HWF
			1919									
			Jan 30	10.0–10.9 (3)	4 44.2 W					3		HWF
			Feb 10, 11	10.3–12.4 (6)	4 45.5 W					3		HWF
			Aug 19			9.7–14.5	71 11.4 N				EI 48	HWF
			1914									
Washington, S. M. O., S_m[1]	38 57.4 N	282 56	Aug 21	4.8–10.0 (dv)	4 29.5 W			11.3–12.5	.19099	7		JAF
			Aug 21	12.9	4 36.4 W					7		JAF
			Sep 15, 16	9.7–15.5 (6)	4 34.4 W			10.2–15.0	.19078	3		CWH
			Sep 19			10.4–15.6	70 59.0 N				EI 48	CWH
			Oct 19, 20, 21	9.2–16.3 (6)	4 33.7 W			10.0–15.0	.19067	3		ADP
			Oct 21, 22, 23			9.9–17.2	70 58.7 N				EI 48	ADP
			Oct 28, 29, 30, 31			9.4–16.2	70 59.6 N				EI 48	HFJ
			Nov 2			9.0–11.3	71 00.2 N				EI 48	HFJ
			Nov 5, 6	9.4–15.4 (7)	4 32.9 W			9.9–14.9	.19055	3		HFJ
			Nov 15, 16	10.1–16.1 (6)	4 33.9 W			9.3–15.2	.19059	3		HFJ
			Nov 30	10.5–15.2 (5)	4 33.9 W			11.0–15.6	.19057	3		IAL
			Dec 1, 2	10.1–14.7 (13)	4 34.0 W			9.7–15.2	.19060	3		IAL

[1] See foot-note 1, p. 71.

NORTH AMERICA.

UNITED STATES—*Continued.*

Station	Latitude	Long. East of Gr.	Date	Declination		Inclination		Hor. Intensity		Instruments		Obs'r
				Local Mean Time	Value	L. M. T.	Value	L. M. T.	Value	Mag'r	Dip Circle	
	° ′	° ′		h h	° ′	h h	° ′	h h	c. g. s.			
Washington, S. M. O., S_m—*Continued*[1]	38 57.4 N	282 56	*1914* Dec 3, 4, 5			9.8–15.4	70 59.4 N				EI 48	IAL
			1915 Jan 4, 5, 6	11.1–16.0 (10)	4 35.8 W			9.8–14.6	.19037	3		DWB
			Jan 7, 8			10.5–15.8	71 00.1 N				EI 48	DWB
			Jan 11, 12	10.2–16.0 (7)	4 34.1 W			11.1–15.5	.19049	3		HWF
			Jan 13, 14	10.2–15.8 (17)	4 34.6 W					3		HWF
			Jan 15, 16	9.1–15.7 (8)	4 34.0 W			10.3–15.2	.19048	3		HWF
			Jan 18	10.3–15.0 (4)	4 34.3 W			11.8–13.7	.19039	3		HWF
			Jan 19, 20, 21, 22, 23			9.5–16.2	71 00.3 N				EI 48	F&B
			Jan 25, 26, 27, 28, 29			9.3–16.0	71 00.7 N				EI 48	HWF
			Feb 5, 6, 8			9.6–16.2	71 01.3 N				EI 48	HME
			Feb 9, 11, 12			9.2–15.4	71 00.5 N				EI 48	HME
			Feb 13, 14, 15			9.8–15.9	70 59.9 N				EI 48	E&K
			Feb 15, 16, 17, 18, 19, 20	8.7–17.0 (20)	4 32.9 W					3		L,B,S
			Feb 16, 17, 18, 19, 20					9.7–16.3	.19045	3		DWB
			Feb 25, 26	9.5–16.0 (6)	4 36.4 W			10.1–15.0	.19034	3		EK
			Feb 26, 27			9.6–15.4	71 00.3 N				EI 48	EK
			Mar 1, 2, 5, 6			9.8–16.0	71 00.4 N				EI 48	EK
			Mar 3, 4	9.6–15.5 (8)	4 35.8 W			10.5–15.0	.19027	3		EK
			Mar 5, 6	11.0–15.2 (8)	4 36.8 W					3		F&K
			Mar 12	9.0–16.3 (7)	4 36.7 W			9.7–15.9	.19026	3		HWF
			Mar 15, 16			9.5–15.7	71 01.2 N				EI 48	HWF
			Apr 20, 21, 22	9.0–14.6 (7)	4 36.0 W			9.8–16.1	.19033	3		HWF
			Jun 7, 8	9.7–16.7 (6)	4 38.3 W			9.6–17.1	.19040	3		EK
			Jun 28, 29	11.3–15.5 (6)	4 38.9 W			9.4–14.4	.19013	3		EK
			Jul 9, 10, 12	9.2–16.4 (6)	4 37.1 W					3		EK
			Jul 10, 12					9.9–14.8	.18995	3		EK
			Sep 3, 13	10.4–16.9 (7)	4 41.1 W			11.9–16.5	.18993	3		HRS
			Sep 16, 17, 18	9.1–16.0 (12)	4 38.6 W			9.3–15.9	.18970	3		HRS
			Sep 24, 25, 27	8.9–16.6 (6)	4 36.8 W			9.7–16.0	.18962	3		ADP
			Nov 29, 30	12.0–16.2 (4)	4 37.3 W					3		HWF
			Nov 30					11.0–15.5	.18980	3		HWF
			Dec 1	9.2–12.0 (2)	4 36.9 W			10.3–11.3	.18974	3		HWF
			1916 Feb 21, 23, 24, 25	9.3–14.1 (7)	4 39.1 W			10.3–15.6	.18955	3		WFW
			Mar 2, 3, 4	10.1–15.4 (6)	4 39.4 W			9.4–16.2	.18959	3		WFW
			Mar 6					10.1–15.5	.18934	3		WFW
			Mar 7	15.2–16.6 (dv)	4 42.9 W					3		WFW
			Mar 11, 13	10.2–15.2 (6)	4 39.7 W			9.5–15.9	.18921	3		WFW
			Apr 4, 5, 6	8.8–15.8 (6)	4 36.0 W			9.4–15.2	.18939	3		WFW
			Apr 21, 22	8.9–17.0 (7)	4 39.6 W			10.0–16.0	.18943	3		DMW
			Aug 9, 10	11.6–16.0 (3)	4 42.1 W					3		HRS
			Aug 21, 22, 23, 25	9.8–17.3 (6)	4 44.1 W			10.5–16.7	.18910	3		HRS
			Aug 28, 29, 30					10.7–16.0	.18907	3		HRS
			Aug 29, 30	10.2–15.2 (6)	4 43.5 W					3		HRS
			Sep 13, 14	11.5–15.4 (6)	4 45.2 W			9.4–14.8	.18892	3		HRS
			1917 Jun 30	10.1–12.2 (2)	4 40.5 W			10.6–11.8	.18858	3		HWF
			Jul 2, 3	9.3–16.1 (10)	4 43.8 W			9.7–16.5	.18878	3		HWF

[1] See foot-note 1, p. 71.

NORTH AMERICA.

UNITED STATES—*Continued.*

Station	Latitude	Long. East of Gr.	Date	Declination: Local Mean Time	Declination: Value	Inclination: L. M. T.	Inclination: Value	Hor. Intensity: L. M. T.	Hor. Intensity: Value	Instruments: Mag'r	Instruments: Dip Circle	Obs'r
	° ′	° ′	*1917*	h h	° ′	h h	° ′	h h	c. g. s.			
Washington, S. M. O., S_m—*Concluded*[1]	38 57.4 N	282 56	Aug 20,21, 23,24	....	....	....	....	10.2–17.2	.18833	3	....	JMM
			Aug 20,21, 24,25	9.1–17.0 (11)	4 44.5 W	....	....	....	....	3	....	JMM
			Oct 9	....	....	....	....	10.2–15.2	.18859	3	....	DMW
			Oct 17,19, 20	11.4–17.0 (6)	4 45.7 W	....	....	11.1–16.2	.18851	3	....	AT
			Oct 27,31	10.4–16.8 (5)	4 44.1 W	....	....	....	....	3	....	W&T
			Nov 1, 2	10.2–14.6 (4)	4 42.6 W	....	....	....	....	3	....	AT
			Nov 15,16, 17	11.5–16.6 (6)	4 44.5 W	....	....	....	....	3	....	AT
			Nov 16,17	....	....	....	....	10.2–16.0	.18826	3	....	AT
			Dec 4	10.7–15.4 (6)	4 42.9 W	....	....	....	....	3	....	AT
			Dec 4, 5	....	....	....	....	10.8–13.6	.18818	3	....	AT
			Dec 10,12, 13	11.2–15.8 (6)	4 43.4 W	....	....	....	....	3	....	AT
			Dec 11,12, 13	....	....	....	....	11.0–15.3	.18831	3	....	AT
			1918									
			Feb 13,14	11.2–17.1 (6)	4 45.8 W	....	....	10.2–16.4	.18804	3	....	DMW
			Mar 12,16	10.7–12.6 (6)	4 45.3 W	....	....	....	....	3	....	DMW
			Mar 13,14	....	....	....	....	10.6–15.5	.18804	3	....	DMW
			Mar 21	....	....	....	....	14.1–16.3	.18808	3	....	DMW
			Mar 22	13.6–13.9 (2)	4 45.7 W	....	....	....	....	3	....	DMW
			Apr 24,25	8.4–13.6 (6)	4 41.4 W	....	....	9.7–15.3	.18831	3	....	DMW
			Apr 29	9.8–16.2 (3)	4 42.3 W	....	....	....	....	3	....	AT
			Apr 29,30	....	....	....	....	8.5–14.1	.18816	3	....	AT
			May 15,16	....	....	....	....	11.6–15.5	.18852	3	....	A&T
			Jun 8	13.8–20.1 (dv)	4 42.5 W	....	....	....	....	2	....	CRD
			Jun 14	....	....	....	....	10.0–14.7	.18824	3	....	ADP
			Jun 17,18, 19,20	8.8–15.2 (13)	4 43.9 W	....	....	9.3–15.0	.18828	3	....	JPA
			Jun 28,29	....	....	....	....	9.8–13.9	.18834	3	....	ADP
			Jul 1, 2	....	....	....	....	10.0–10.1	.18826	3	....	ADP
			Jul 16	8.6–15.4 (6)	4 41.3 W	....	....	9.0–15.0	.18822	3	....	DMW
			1919									
			Jan 23,24	....	....	....	....	10.5–15.2	.18756	3	....	HWF
			Jan 24	10.0–15.1 (6)	4 45.3 W	....	....	....	....	3	....	HWF
			Feb 10,11	9.8–15.7 (9)	4 45.7 W	....	....	....	....	3	....	HWF
			Feb 14,15	11.6–16.0 (6)	4 47.4 W	....	....	9.9–14.8	.18753	3	....	HWF
			Feb 24,25	....	....	....	....	11.0–16.2	.18770	3	....	HWF
			Feb 24,25, 26	9.9–16.0 (6)	4 45.7 W	....	....	....	....	3	....	HWF
			May 27	13.2	4 46.0 W	....	....	....	....	3	....	CRD
			May 28	4.8–11.3 (dv)	4 43.1 W	....	....	....	....	3	....	CRD
			May 29	4.8–11.5 (dv)	4 42.1 W	....	....	....	....	3	....	CRD
			May 30	4.8–11.6 (dv)	4 42.8 W	....	....	....	....	3	....	CRD
			Jun 25	10.4–13.4 (4)	4 47.0 W	....	....	....	....	3	....	F&M
			Aug 7, 8 9	8.6–14.0 (9)	4 48.0 W	....	....	9.0–15.6	.18754	3	....	F&G
			Aug 12,15	9.0–15.2 (2)	4 49.7 W	....	....	....	....	3	....	HWF
			Aug 20	14.8–18.3 (dv)	4 47.7 W	....	....	....	....	3	....	F,G,M
			Aug 22,23	....	....	....	....	8.6–13.8	.18723	3	....	HRG
			Aug 25	....	....	....	....	10.0–15.3	.18760	3	....	RRM
			Aug 28,29	9.2–15.5 (6)	4 48.6 W	....	....	8.7–15.0	.18747	3	....	HRG
			Sep 3	8.6– 8.8 (2)	4 42.0 W	....	....	....	....	3	....	HWF
			Sep 25	15.6–17.7 (dv)	4 50.3 W	....	....	....	....	3	....	HRG
			Nov 1, 3	10.8–14.5 (6)	4 47.2 W	....	....	10.1–15.0	.18735	3	....	DMW
			Nov 21	16.8	4 44.8 W	....	....	....	....	3	....	CCE
			Nov 22	6.9–13.6 (dv)	4 51.2 W	....	....	....	....	3	....	CCE
			1915									
Washington, S. M. O., S [1]	38 57.4 N	282 56	Jun 4, 5	....	....	9.3–16.2	70 59.6 N	....	....	....	EI 48	EK
			Jun 30	....	....	11.2–16.0	71 01.2 N	....	....	....	EI 48	EK
			Jul 1	....	....	9.2–12.0	71 01.5 N	....	....	....	EI 48	EK
			Jul 16,17, 19	....	....	9.7–15.3	71 01.1 N	....	....	....	EI 48	EK
			Sep 29,30	....	....	9.6–15.4	71 02.7 N	....	....	....	EI 48	ADP
			Oct 29,30	....	....	9.7–15.6	71 02.8 N	....	....	....	EI 48	HWF
			Nov 1, 2, 3	....	....	10.2–15.8	71 04.0 N	....	....	....	EI 48	HWF
			Dec 3, 4	....	....	9.7–16.0	71 02.7 N	....	....	....	EI 48	HWF
			1916									
			Mar 23, 24	....	....	10.0–17.0	71 03.7 N	....	....	....	EI 48	WFW

[1] See foot-note 1, p. 71.

NORTH AMERICA.

UNITED STATES—*Continued.*

Station	Latitude	Long. East of Gr.	Date	Declination		Inclination		Hor. Intensity		Instruments		Obs'r
				Local Mean Time	Value	L. M. T.	Value	L. M. T.	Value	Mag'r	Dip Circle	
	° ′	° ′	*1916*	h h h	° ′	h h	° ′	h h	c. g. s.			
Washington, S. M. O., S_6—*Concluded*[1]	38 57.4 N	282 56	Apr 8, 10	....	....	9.4–14.6	71 04.2 N	....	....	......	EI 48	WFW
			May 12, 13	....	....	9.7–16.3	71 03.6 N	....	....	......	EI 48	DMW
			Aug 2, 3, 4	....	....	10.2–17.0	71 03.7 N	....	....	......	EI 48	S&S
			Aug 17, 18, 19	....	....	9.2–16.0	71 03.1 N	....	....	......	EI 48	S&T
			Sep 7, 8, 9	....	....	9.5–15.3	71 05.0 N	....	....	......	EI 48	HRS
			Oct 17, 18	....	....	9.1–16.3	71 05.7 N	....	....	......	EI 48	HWF
			Dec 29, 30	....	....	9.6–16.0	71 05.5 N	....	....	......	EI 48	HWF
			1917									
			Jan 6	....	....	11.2–13.6	71 07.7 N	....	....	......	EI 48	HWF
			Oct 9, 27	....	....	9.0–15.9	71 06.8 N	....	....	......	EI 48	DMW
			Nov 7, 8	....	....	10.4–15.7	71 06.4 N	....	....	......	EI 48	AT
			1918									
			Feb 6, 7	....	....	10.1–15.9	71 06.2 N	....	....	......	EI 48	DMW
			Mar 21	....	....	12.9–16.8	71 07.3 N	....	....	......	EI 48	DMW
			Apr 29, 30	....	....	7.8–15.3	71 06.7 N	....	....	......	EI 48	AT
			May 15, 16	....	....	8.2–16.6	71 06.0 N	....	....	......	EI 48	A&T
			Jun 27, 28, 29	....	....	9.0–15.2	71 05.3 N	....	....	......	EI 48	A&P
			Jul 1, 2	....	....	9.2–11.0	71 05.1 N	....	....	......	EI 48	ADP
			Jul 17, 18	....	....	9.0–13.4	71 06.1 N	....	....	......	EI 48	DMW
			1919									
			Jan 29, 30	....	....	10.1–14.5	71 08.5 N	....	....	......	EI 48	HWF
			Feb 17, 18	....	....	10.2–16.0	71 08.6 N	....	....	......	EI 48	HWF
			Jun 24	....	....	11.2–14.6	71 07.7 N	....	....	......	EI 48	F&M
			Aug 20, 21, 22, 23	....	....	8.5–14.4	71 10.7 N	....	....	......	EI 48	F,G,M
			Aug 25, 26, 27, 28	....	....	8.6–15.2	71 09.8 N	....	....	......	EI 48	J&M
			Nov 5	....	....	10.4–15.2	71 10.5 N	....	....	......	EI 48	DMW
Green Mountain Falls	38 55.9 N	254 59	Jun 17, '18	14.1, 15.4	14 15.2 E	12.5	67 09.5 N	14.5, 15.1	.22167	26	EI 26	F&E
Raspberry Mountain	38 54.4 N	254 53	Jun 20, 18	12.2, 13.6	14 27.0 E	14.3	67 18.8 N	12.6, 13.2	.22179	16	242.56	WJP
Cascade	38 53.9 N	255 02	Jun 10, 18	13.2, 15.2	14 52.8 E	11.2	67 07.8 N	13.7, 14.7	.22264	16	242.56	WJP
Midland	38 53.7 N	254 51	Jun 21, 18	15.9, 17.4	14 32.0 E	15.2	67 10.0 N	16.4, 17.0	.22264	26	EI 26	F&E
Glen Cove	38 52.5 N	254 56	Jun 13, 18	12.2, 14.1	14 19.6 E	10.7	67 06.4 N	13.0, 13.7	.22286	16	242.56	WJP
Manitou, *A*	38 51.9 N	255 05	Jun 12, 18	17.3	16 22.2 E	....	....	....	....	14	....	LAB
			Jun 13, 18	10.8, 15.7	16 29.8 E	17.8	67 20.6 N	15.3	.22400	14	14.5	LAB
			Jun 14, 18	10.1, 14.1	16 34.2 E	15.3	67 17.4 N	10.8, 13.7	.22413	26	EI 26	F&E
			Jun 14, 18	....	....	16.6	67 18.0 N	....	....	......	14.15	F&E
Mount Manitou, *Eagle Cliffs*	38 51.6 N	255 03	Jun 11, 18	13.5, 15.1	15 19.8 E	11.4	67 11.0 N	13.9, 14.7	.22238	16	242.56	WJP
Mount Manitou, *Fremont Experiment Station*	38 51.4 N	255 02	Jun 12, 18	13.2, 15.0	15 14.6 E	12.4	67 05.0 N	13.8, 14.7	.22316	16	242.56	WJP
Sentinel	38 51.0 N	254 55	Jun 21, 18	....	....	11.5	67 06.8 N	12.7, 13.4	.22270	16	242.56	WJP
Iron Mountain*	38 50.9 N	255 05	Jun 25, 18	13.0, 14.5	1 45.8 E	15.1	67 10.7 N	13.4, 14.1	.23226	26	EI 26	F&E
Halfway	38 50.6 N	255 02	Jun 14, 18	12.4, 14.2	15 11.2 E	10.9	67 02.8 N	12.8, 13.8	.22340	16	242.56	P&F
Pikes Peak, *A*	38 50.4 N	254 57	Jun 17, 18	14.7, 16.6	14 32.8 E	13.2	67 08.0 N	15.3, 16.1	.22259	16	242.56	WJP
Pikes Peak, *B*	38 50.4 N	254 57	Jun 18, 18	9.1, 10.8	14 36.2 E	11.6	67 08.4 N	9.5, 10.2	.22226	16	242.56	WJP
			Jun 19, 18	13.8, 15.4	14 31.4 E	16.9	67 11.3 N	14.2, 15.0	.22237	26	EI 26	HWF
			Jun 20, 18	10.4, 12.2	14 29.5 E	13.1	67 08.8 N	11.1, 11.9	.22264	26	EI 26	HWF
Pikes Peak, *C*	38 50.4 N	254 57	Jun 18, 18	14.5, 16.2	14 39.0 E	....	....	14.9, 15.7	.22292	16	....	WJP
			Jun 19, 19	....	....	5.8	67 05.8 N	....	....	......	242.56	WJP
Mountain View	38 50.1 N	255 00	Jun 15, 18	13.7, 14.7	14 46.2 E	13.3	67 07.3 N	14.0, 14.5	.22306	26	EI 26	F&E
Lake Moraine, *A*	38 49.0 N	255 00	Jun 7, 18	8.8, 13.6	14 57.1 E	11.5	67 06.2 N	11.6	*.2228*	*242*	242.127	WJP
Lake Moraine, *B*	38 49.0 N	255 00	Jun 8, 18	9.1	14 53.9 E	....	....	....	....	16	....	WJP
			Jun 8, 18	12.0 to 18.0 (dv)	14 56.1 E	....	....	....	....	16	....	WJP
Windy Point	38 48.9 N	254 59	Jun 15, 18	13.4, 14.7	14 32.5 E	12.4	67 04.7 N	13.8, 14.3	.22288	16	242.56	WJP
Jones Park	38 47.6 N	255 04	Jun 6, 18	10.7, 14.5	15 24.0 E	15.5	67 05.4 N	13.1, 14.1	.22390	16	242.12	WJP
Broadmoor	38 47 N	255 09	Jun 15, 18	14.1, 14.8	14 44.2 E	16.2	67 26.9 N	14.1	.22262	14	14.5	LAB
Gillett	38 46.9 N	254 53	Jun 22, 18	14.1, 15.9	14 01.4 E	16.7	67 18.2 N	14.8, 15.6	.22030	26	EI 26	F&E
Trachyte Mountain	38 46.5 N	254 54	Jun 23, 18	12.0, 13.7	14 04.9 E	14.4	67 24.5 N	12.4, 13.2	.21961	26	EI 26	F&E
Cow Mountain	38 45.9 N	254 55	Jun 24, 18	12.9	14 08.3 E	14.9	67 20.1 N	13.3, 13.8	.21923	26	EI 26	HWF
Cheltenham, B_i	38 44.0 N	283 10	Jun 10, 15	14.4, 17.0	6 05.5 W	....	....	14.9, 15.9	.19446	26	....	HWF
			Jun 11, 15	9.1, 14.0	6 03.8 W	....	....	7.4, 8.3	.19416	26	....	HWF
			Jun 11, 15	14.7, 15.5	6 06.2 W	....	....	11.0, 11.7	.19416	26	....	HWF
			June 12, 15	9.7, 11.8	6 08.0 W	....	....	7.9, 8.9	.19421	26	....	HWF
			Jun 12, 15	13.4, 14.9	6 11.1 W	....	....	12.3, 13.0	.19434	26	....	HWF
			Jun 14, 15	9.4, 11.0, 11.6	6 04.2 W	....	....	7.7, 8.6	.19398	26	....	HWF
			Jun 14, 15	15.5, 15.7, 16.6	6 06.8 W	....	....	13.7, 14.8	.19430	26	....	HWF
			Jun 15, 15	9.1, 15.2	6 04.6 W	....	....	7.6, 8.4	.19424	26	....	HWF

* Local disturbance.

[1] See foot-note 1, p. 71.

NORTH AMERICA.

UNITED STATES—*Continued.*

Station	Latitude	Long. East of Gr.	Date	Declination: Local Mean Time	Declination: Value	Inclination: L. M. T.	Inclination: Value	Hor. Intensity: L. M. T.	Hor. Intensity: Value	Instruments: Mag'r	Instruments: Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Cheltenham, B_i—*Concluded*	38 44.0 N	283 10	Jun 15, '15	....	....	....	....	11.4,14.5	.19422	26	....	HWF
			Jun 16, 15	....	....	10.7 to 16.8 (10)	70 48.4 N	....	....	......	EI 26	HWF
			Jun 18, 15	....	....	13.6 to 16.5 (7)	70 50.4 N	....	....	......	EI 26	HWF
			Jun 19, 15	....	....	10.5,11.0	70 51.0 N	....	....	......	EI 26	HWF
			Jun 19, 15	....	....	13.4,14.0	70 49.9 N	....	....	......	EI 26	HWF
			Jun 22, 15	....	....	10.0	70 50.6 N	....	....	......	EI 26	HWF
			Jun 23, 15	....	....	13.9 to 16.4 (6)	70 48.3 N	....	....	......	EI 26	HWF
			Jan 2, 17	....	....	9.9 to 16.2 (12)	70 52.7 N	....	....	......	EI 26	HRS
			Jan 5, 17	....	....	11.6 to 16.3 (12)	70 54.6 N	....	....	......	EI 26	HRS
Cheltenham, (*EI*)′	38 44.0 N	283 10	Jun 19, 15	....	....	16.0,16.9	70 49.0 N	....	....	......	EI 26	HWF
			Jun 21, 15	....	....	9.0 to 16.8 (8)	70 48.9 N	....	....	......	EI 26	HWF
			Jan 3, 17	....	....	10.2 to 16.4 (10)	70 52.0 N	....	....	......	EI 26	HRS
Cheltenham, *O*	38 44.0 N	283 10	Jun 22, 15	13.9 to 17.2 (7)	6 06.2 W	....	....	....	....	26	....	HWF
Cove Point Lighthouse	38 23.1 N	283 37	Jun 30, 19	14.2	6 11.3 W	15.3	70 26.1 N	14.5	.19419	25	EI 25	F,G,M
Charity Point	38 20.8 N	283 46	Jul 1, 19	11.6,13.7	6 57.8 W	14.6	70 12.0 N	12.4,13.5	.19602	25	EI 25	HWF
Barren Island	38 20.5 N	283 44	Jul 1, 19	9.8,12.6	7 00.0 W	13.4	70 13.0 N	10.6,12.1	.19631	5	202.(78)	G&M
Solomons, *A*	38 19.0 N	283 33	Jun 27, 19	11.0,15.2	6 19.2 W	....	....	12.4,14.4	.19574	25	....	F,G,M
			Jun 28, 19	....	....	12.2	70 22.0 N	....	....	......	EI 25	F,G,M
Solomons, *B*	38 19.0 N	283 33	Jun 28, 19	10.2	6 17.4 W	....	....	12.9,15.3	.19572	5	....	G&M
Cedar Point	38 18.0 N	283 38	Jun 30, 19	10.4,12.0	6 18.2 W	9.7	70 18.0 N	11.0,11.7	.19592	25	EI 25	F,G,M
Middle Hooper Island	38 16.7 N	283 49	Jul 8, 19	8.8,12.4	6 22.1 W	14.5	70 18.4 N	9.4,11.0	.19442	5	202.(78)	G&M
Applegarth	38 14.9 N	283 51	Jul 7, 19	13.4	6 28.5 W	15.4	70 17.1 N	13.8,14.5	.19513	25	EI 25	F,G,M
Cedar Point Hollow 3	38 14.3 N	283 36	Jul 3, 19	10.1,14.3	6 23.2 W	13.7	70 13.8 N	10.6,11.5	.19593	25	EI 25	F&M
Cedar Point Hollow 1	38 12.7 N	283 37	Jul 2, 19	13.1	6 28.8 W	14.0	70 10.2 N	11.0,12.7	.19656	5	202.(78)	G&M
Cedar Point Hollow 2	38 11.3 N	283 38	Jul 2, 19	13.2,15.0	6 28.2 W	11.2	70 10.1 N	13.7,14.6	.19640	25	EI 25	HWF
Point No Point	38 08.3 N	283 41	Jul 3, 19	11.0,13.8	6 22.5 W	10.6	70 16.0 N	11.8,13.4	.19520	5	202.(7)	HRG
Holland Island	38 06.8 N	283 54	Jul 8, 19	12.5,13.9	6 25.6 W	14.6	70 14.1 N	12.9,13.5	.19556	25	EI 25	HWF
Point Lookout	38 03.0 N	283 41	Jul 5, 19	11.8,13.2	6 31.6 W	13.8	70 09.9 N	12.1,12.7	.19696	25	EI 25	F,G,M
San Rafael	37 58.6 N	237 27	Jul 22, 16	9.4,10.8	18 18.4 E	13.8	62 12.4 N	9.9,10.5	.24910	14	14.1256	HFJ
			Jul 22, 16	12.7,14.6	18 12.4 E	....	....	....	....	14	....	HFJ
Lakin, *C. & G. S.*	37 57.6 N	258 45	Jun 27, 18	10.5,12.0	12 42.4 E	14.3,14.5	67 00.6 N	10.9,11.6	.22722	10	EI 5	DMW
Lakin, *Eclipse*	37 53.2 N	258 42	Jun 5, 18	14.8,17.3	12 27.9 E	11.9,12.1	66 56.6 N	15.4,16.7	.22730	10	EI 5	DMW
			Jun 7, 18	9.4,11.6	12 29.2 E	15.0,15.2	66 56.7 N	9.9,11.0	.22704	10	EI 5	DMW
			Jun 8, 18	12.3 to 18.5 (dv)	12 27.2 E	....	....	....	....	10	....	DMW
			Jun 9, 18	9.3,11.6	12 31.6 E	13.8,14.1	66 58.4 N	9.8,11.1	.22700	10	EI 5	DMW
			Jun 11, 18	9.7,12.0	12 31.1 E	18.5,18.6	66 59.8 N	10.2,11.5	.22679	10	EI 5	DMW
			Jun 14, 18	13.9,16.6	12 29.0 E	9.3, 9.5	66 59.2 N	14.4,16.1	.22700	10	EI 5	DMW
			Jun 18, 18	8.0,10.1	12 32.7 E	11.4,11.6	66 57.8 N	8.4, 9.7	.22698	10	EI 5	DMW
			Jun 21, 18	14.6,16.5	12 28.0 E	10.9,11.2	66 57.3 N	15.1,16.1	.22714	10	EI 5	DMW
			Jun 24, 18	8.5,10.3	12 32.4 E	15.8,18.0	66 57.8 N	9.0, 9.9	.22700	10	EI 5	DMW
			Jun 26, 18	14.6,16.5	12 24.4 E	18.0,18.2	66 59.6 N	15.1,16.1	.22698	10	EI 5	DMW
Goat Island, *A*	37 48.7 N	237 38	Jul 19, 16	9.9,11.4	18 16.9 E	....	....	10.4,11.0	.24974	14	....	HFJ
			Jul 20, 16	8.2,10.0	18 19.8 E	9.1	62 04.2 N	....	....	14	14.1256	HFJ
			Sep 27, 16	....	....	9.6 to 15.1 (13)	62 06.4 N	....	....	......	EI 25	C IV
			Sep 27, 16	....	....	16.2,16.5	62 04.4 N	....	....	......	EI 3	C IV
			Sep 28, 16	....	....	9.0 to 15.1 (14)	62 05.7 N	....	....	......	EI 3	C IV
			Sep 29, 16	9.7,12.1,13.3	18 17.2 E	....	....	10.3,11.6	.24990	5	....	C IV
			Sep 29, 16	15.5,15.9,16.2	18 15.2 E	....	....	13.9,15.0	.25017	5	....	C IV
			Oct 3, 16	9.9,15.7	18 18.8 E	....	....	11.2,14.5	.24982	5	....	C IV
			Oct 4, 16	9.0,11.0,11.3	18 19.0 E	....	....	9.5 to 16.1 (6)	.24994	25	....	C IV
			Oct 4, 16	14.0,14.4,16.6	18 15.7 E	....	....	....	....	25	....	C IV
			Oct 5, 16	14.1 to 17.0 (dv)	18 14.8 E	8.8,10.6	62 04.6 N	9.6,12.6	.24986	25	EI 25	C IV
			Oct 5, 16	....	....	11.4,13.9	62 05.0 N	....	....	......	EI 25	C IV
			Oct 6, 16	....	....	9.0 to 15.6 (8)	62 07.8 N	10.0,11.5	.24966	25	EI 25	C IV
			Oct 9, 16	8.9 to 14.4 (4)	18 19.5 E	....	....	9.3 to 14.0 (6)	.24960	25	....	C IV
			Oct 10, 16	9.9,12.2,14.8	18 15.6 E	....	....	10.4,11.7	.24982	25	....	C IV
			Oct 10, 16	....	....	....	....	13.5	.24955	25	....	C IV
			Oct 11, 16	9.0 to 14.8 (4)	18 17.3 E	....	....	9.5 to 14.4 (6)	.24966	25	....	C IV
			Oct 16, 16	....	....	9.1 to 15.4 (8)	62 05.7 N	10.4,11.4	.24978	25	EI 25	C IV
			Oct 16, 16	....	....	....	....	14.0	.24976	25	....	C IV

NORTH AMERICA.

UNITED STATES—*Concluded.*

Station	Latitude	Long. East of Gr.	Date	Declination		Inclination		Hor. Intensity		Instruments		Obs'r
				Local Mean Time	Value	L. M. T.	Value	L. M. T.	Value	Mag'r	Dip Circle	
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Goat Island, *A*—*Concluded*	37 48.7 N	237 38	Oct 17, '16	8.8 to 15.2 (4)	18 16.9 E	....	....	9.8 to 14.9 (5)	.24990	25	....	C IV
			Oct 18, 16	9.4 to 15.3 (4)	18 17.4 E	....	....	9.9 to 14.9 (6)	.24993	25	....	C IV
			Oct 19, 16	8.3, 9.9,11.5	18 18.3 E	....	....	8.7, 9.5	.25000	25	....	C IV
			Oct 19, 16	14.3 to 16.9 (dv)	18 14.5 E	....	....	10.3,11.1	.25002	25	....	C IV
			Oct 20, 16	....	....	....	....	9.3,10.1	.24996	25	....	C IV
			Oct 20, 16	....	....	....	....	11.1,12.7	.25010	25	....	C IV
			Oct 23, 16	6.9 to 9.5 (dv)	18 16.9 E	....	....	....	....	5	....	C IV
			Oct 25, 16	....	....	8.9 to 14.0 (13)	62 05.3 N	....	....	......	EI 25	C IV
			Oct 26, 16	8.0 to 9.8 (dv)	18 20.6 E	....	....	....	....	25	....	C IV
Goat Island, *B*..........	37 48.7 N	237 38	Sep 27, 16	....	....	9.6 to 15.1 (13)	62 05.7 N	....	....	......	EI 3	C IV
			Sep 27, 16	....	....	16.2,16.5	62 04.8 N	....	....	......	EI 25	C IV
			Sep 28, 16	....	....	9.0 to 15.1 (14)	62 05.4 N	....	....	......	EI 25	C IV
			Sep 29, 16	9.7,12.2,13.3	18 16.4 E	....	....	10.3,11.6	.24980	25	....	C IV
			Sep 29, 16	15.5,15.9,16.2	18 15.0 E	....	....	13.9,15.0	.25006	25	....	C IV
			Oct 3, 16	9.9,15.7	18 17.0 E	....	....	11.1,14.5	.24984	25	....	C IV
			Oct 4, 16	9.0,11.0,11.3	18 18.7 E	....	....	9.5 to 16.2 (6)	.24988	5	....	C IV
			Oct 4, 16	14.0,14.4,16.6	18 15.2 E	....	....	....	....	5	....	C IV
			Oct 13, 16	12.8 to 15.5 (10)	18 13.9 E	....	....	....	....	25	....	C IV
			Oct 25, 16	....	....	8.9 to 14.0 (13)	62 04.6 N	....	....	......	EI 3	C IV
Langley Field, *A*.........	37 04.8 N	283 39	Sep 13, 17	15.6	5 21.0 W	....	....	....	....	26	....	HWF
			Sep 14, 17	12.0	5 24.6 W	15.5	69 20.2 N	12.8,14.2	.20301	26	EI 26	HWF
Langley Field, *B*.........	37 04.5 N	283 39	Sep 17, 17	11.0	5 28 W	....	....	....	....	26	....	HWF
Langley Field, *C**........	37 04.5 N	283 39	Sep 17, 17	15.9	4 59 W	....	....	....	....	26	....	HWF
Langley Field, *D**........	37 04.5 N	283 39	Sep 17, 17	16.2	4 31 W	....	....	....	....	26	....	HWF
Hampton................	37 00.7 N	283 40	Sep 18, 17	11.0,13.4	5 27.4 W	14.5	69 17.5 N	11.6,12.7	.20345	26	EI 26	HWF
San Diego, *III*...........	32 44.7 N	242 48	Jul 29, 16	10.3,12.0	15 13.9 E	....	....	10.9,11.6	.27293	14	....	HFJ
			Jul 29, 16	13.1,15.7	15 13.4 E	13.9	58 07.1 N	....	....	14	14.1256	HFJ
Brewton.................	31 06.9 N	272 55	Jun 4, 18	....	....	14.7	62 51.8 N	....	....	......	206.56(2X)	CWH
			Jun 5, 18	14.0,17.6	4 19.6 E	....	....	15.6,16.9	.25208	4	....	CWH
			Jun 6, 18	8.1,11.2	4 21.6 E	....	....	8.9,10.6	.25208	4	....	CWH
			Jun 7, 18	13.1 to 19.6 (dv)	4 18.9 E	....	....	....	....	4	....	CWH
			Jun 8, 18	12.4	4 15.9 E	....	....	....	....	4	....	CWH
			Jun 8, 18	13.2 to 19.4 (dv)	4 18.7 E	....	....	....	....	4	....	CWH
			Jun 9, 18	12.6 to 19.4 (dv)	4 16.7 E	....	....	....	....	4	....	CWH
Austin, *Esperanza Schoolhouse*...........	30 20.4 N	262 16	Jun 7, 18	8.6,14.9	9 10.2 E	....	....	13.6,14.3	.26928	9710	....	JMK
			Jun 8, 18	11.2 to 19.1 (dv)	9 07.2 E	....	....	....	....	9710	....	JMK
			Jun 10, 18	....	....	9.0	60 05.0 N	....	....	......	23.2(2)	JMK

SOUTH AMERICA.

ARGENTINA.

Station	Latitude	Long. East of Gr.	Date	Decl. L. M. T.	Decl. Value	Incl. L. M. T.	Incl. Value	H. I. L. M. T.	H. I. Value	Mag'r	Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
La Quiaca..............	22 06.6 S	294 25	Aug 17, '17	10.0,12.5	6 28.0 E	14.2,14.6	12 51.2 S	10.5	.26598	25	EI 25	LLT
			Aug 18, 17	9.1,11.9	6 28.0 E	....	....	9.9,11.1	.26629	25	....	LLT
Humahuaca.............	23 12.7 S	294 38	Aug 22, 17	10.2,12.6	6 42.2 E	14.4,14.6	14 24.4 S	10.7,12.0	.26352	25	EI 25	LLT
			Aug 23, 17	....	....	....	....	9.2,10.6	.26354	25	....	LLT
Embarcacion............	23 13.2 S	295 55	Aug 11, 17	10.0,14.0	5 48.4 E	15.2,15.4	14 03.2 S	10.9,13.4	.26206	25	EI 25	LLT
Ledesma...............	23 49.5 S	295 13	Aug 12, 17	13.3,15.7	6 30.7 E	10.8,11.0	15 05.0 S	13.8,15.1	.26268	25	EI 25	LLT
Jujuy..................	24 11.4 S	294 43	Aug 14, 17	9.6,13.1	6 51.6 E	14.6,14.8	16 00.6 S	10.3,11.8	.26193	25	EI 25	LLT
			Aug 15, 17	9.1, 9.3,12.1	6 55.8 E	....	....	10.0,11.5	.26266	25	....	LLT
			Aug 15, 17	....	....	....	....	14.0,15.0	.26221	25	....	LLT
Salta, *A*................	24 47.6 S	294 36	Aug 7, 17	12.2,15.9	7 10.7 E	....	....	13.8,15.3	.26173	25	....	LLT
Salta, *B*................	24 47.6 S	294 36	Aug 8, 17	....	....	13.2,13.5	16 52.6 S	....	....	......	EI 25	LLT
			Aug 9, 17	9.5,14.6	7 11.3 E	....	....	12.4,13.9	.26075	25	....	LLT
Talapampa..............	25 33.0 S	294 27	Aug 5, 17	....	....	14.8,15.0	17 57.5 S	....	....	......	EI 25	LLT
			Aug 6, 17	9.8,12.6	7 28.0 E	....	....	10.3,11.5	.26188	25	....	LLT
			Aug 6, 17	14.1,16.5	7 29.4 E	....	....	14.8,16.0	.26132	25	....	LLT
Rosario de la Frontera....	25 48.0 S	295 01	Aug 26, 17	9.4,12.6	7 09.0 E	14.1,14.6	18 11.4 S	10.0,11.3	.25998	25	EI 25	LLT
Tucuman...............	26 51.1 S	294 46	Aug 3, 17	13.4,15.7	7 43.3 E	11.5,11.7	19 31.8 S	14.0,15.2	.25922	25	EI 25	LLT

* Local disturbance.

SOUTH AMERICA.

ARGENTINA—*Continued.*

Station	Latitude	Long. East of Gr.	Date	Declination		Inclination		Hor. Intensity		Instruments		Obs'r
				Local Mean Time	Value	L. M. T.	Value	L. M. T.	Value	Mag'r	Dip Circle	
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
La Madrid	27 39.3 S	294 44	Aug 1, '17	13.4,15.4	7 59.0 E	11.7,11.9	20 52.7 S	13.9,15.0	.25792	25	EI 25	LLT
Santiago del Estero	27 46.6 S	299 44	Aug 29, 17	13.5,15.8	7 13.1 E	11.1,11.3	20 34.2 S	14.0,15.2	.25706	25	EI 25	LLT
Tinogasta	28 04.1 S	292 26	Sep 18, 17	9.9,12.8	9 33.3 E	14.4,14.6	22 18.5 S	10.4,11.9	.26176	25	EI 25	LLT
Frias	28 39.0 S	294 52	Aug 28, 17	9.8,11.8	7 51.4 E	14.5,14.8	22 03.2 S	10.8,11.4	.25648	25	EI 25	LLT
Chilecito	29 10.2 S	292 30	Sep 15 17	9.5,11.6	9 47.2 E	14.2,14.4	23 45.7 S	10.0,11.2	.26168	25	EI 25	LLT
Recreo	29 17.1 S	295 56	Aug 2, 17	10.0,12.6	8 14.8 E	14.0,14.5	22 57.2 S	10.4,11.6	.25653	25	EI 25	LLT
La Rioja	29 25.3 S	293 09	Sep 20, 17	9.6,12.8	9 46.3 E	14.1,14.3	23 38.0 S	10.4,11.9	.26004	25	EI 25	LLT
Chamical	30 21.5 S	293 42	Sep 12, 17	9.9,12.8	9 25.4 E	14.2,14.4	24 45.3 S	10.6,12.0	.25782	25	EI 25	LLT
Dean Funes	30 25.6 S	295 39	Sep 6, 17	13.0,15.6	8 08.4 E	10.9,11.1	24 08.9 S	13.6,15.0	.25518	25	EI 25	LLT
Serrezuela	30 38.8 S	294 37	Sep 10, 17	10.5,13.7,13.9	8 59.6 E	15.4,15.7	24 44.2 S	11.0,13.2	.25694	25	EI 25	LLT
Mascasin	31 24.0 S	293 01	Sep 7, 17	13.0,16.5	10 29.8 E	11.1,11.3	26 18.8 S	13.7,16.1	.25819	25	EI 25	LLT
			Sep 8, 17	....	....	....	....	10.3,11.6	.25834	25	....	LLT
Cordoba	31 25.3 S	295 48	Jul 30, 17	9.8,12.6	8 29.3 E	13.9,14.2	25 29.8 S	10.3,11.8	.25473	25	EI 25	LLT
San Juan, *A*	31 31.0 S	291 27	Jun 7, 17	10.3	11 16.7 E	14.2,14.8	27 11.8 S	11.1	.26065	25	EI 25	LLT
San Juan, *B*	31 31.0 S	291 28	Jun 8, 17	10.9,15.0	11 19.4 E	16.2,16.4	27 12.6 S	11.4,13.6	.26039	25	EI 25	LLT
Villa del Rosario	31 33.1 S	296 28	Jul 25, 17	9.0,11.4	7 59.6 E	14.7,15.1	25 21.2 S	9.7,11.0	.25422	25	EI 25	LLT
Pilar, *B*	31 40.1 S	296 07	Mar 19, 17	8.9,11.2,11.9	8 15.3 E	....	....	9.5,10.6	.25474	25	....	C IV
			Mar 19, 17	16.0,16.5	8 16.3 E	....	....	14.2,15.3	.25476	25	....	C IV
			Mar 20, 17	8.9,11.7	8 11.4 E	....	....	9.5,11.0	.25486	25	....	C IV
			Mar 26, 17	....	....	10.9 (7)	25 36.7 S	....	....	......	EI 25	C IV
			Mar 27, 17	....	....	8.9 (3)	25 42.3 S	....	....	......	EI 25	C IV
			Apr 3, 17	8.9, 9.2	8 10.0 E	....	....	....	....	5	....	C IV
			Apr 3, 17	14.4 to 16.5 (6)	8 16.6 E	....	....	....	....	5	....	C IV
Pilar, *Pier 4*	31 40.1 S	296 07	Mar 27, 17	....	....	10.5 to 12.6 (9)	25 37.4 S	....	....	......	EI 25	C IV
			Nov 10, 17	....	....	8.5, 8.8	25 38.5 S	....	....	......	EI 25	C V
			Nov 10, 17	....	....	9.9 (4)	25 35.5 S	....	....	......	EI 25	C V
			Nov 13, 17	....	....	9.5, 9.8	25 36.8 S	....	....	......	EI 25	C V
			Nov 13, 17	....	....	11.0 (4)	25 37.1 S	....	....	......	EI 25	C V
Pilar, *Pier 5*	31 40.1 S	296 07	Mar 20, 17	14.1,17.0	8 17.4 E	....	....	14.8,16.0	.25486	25	....	C IV
			Mar 21, 17	8.8,11.8,13.9	8 14.6 E	....	....	9.4,11.0	.25471	25	....	C IV
			Mar 21, 17	....	....	....	....	14.5,15.6	.25460	25	....	C IV
			Apr 4, 17	9.0 to 11.6 (6)	8 12.7 E	....	....	....	....	5	....	C IV
			Nov 9, 17	10.6 to 17.2 (6)	8 11.4 E	....	....	8.8 to 16.8 (6)	.25482	25	....	C V
			Nov 12, 17	8.2 to 16.3 (6)	8 11.2 E	....	....	8.7 to 15.9 (6)	.25431	25	....	C V
Pilar, *E*	31 40.1 S	296 07	Mar 13, 17	9.7,15.0,15.9	8 16.2 E	....	....	10.8,14.5	.25434	25	....	C IV
			Mar 14, 17	8.8,11.5	8 14.4 E	....	....	9.4,11.0	.25442	25	....	C IV
			Mar 14, 17	14.0,16.6	8 19.8 E	....	....	14.4,16.0	.25442	25	....	C IV
			Mar 15, 17	8.7,11.5,12.0	8 12.1 E	....	....	9.4,11.0	.25456	5	....	C IV
			Mar 15, 17	14.0,16.5	8 17.4 E	....	....	14.6,16.0	.25444	5	....	C IV
			Mar 16, 17	8.7,11.3	8 10.7 E	....	....	9.2,10.8	.25465	5	....	C IV
			Mar 16, 17	11.9	8 16.8 E	....	....	....	....	25	....	C IV
			Mar 22, 17	....	....	11.6,11.9	25 37.8 S	....	....	......	EI 3	C IV
			Mar 22, 17	....	....	14.6,15.2	25 41.4 S	....	....	......	EI 3	C IV
			Mar 22, 17	....	....	16.3 (4)	25 43.2 S	....	....	......	EI 3	C IV
			Mar 23, 17	....	....	9.5 (4)	25 41.2 S	....	....	......	EI 3	C IV
			Mar 23, 17	....	....	11.3 (3)	25 38.0 S	....	....	......	EI 25	C IV
			Mar 23, 17	....	....	14.9 (5)	25 41.5 S	....	....	......	EI 25	C IV
			Mar 23, 17	....	....	16.4 (4)	25 43.6 S	....	....	......	EI 25	C IV
			Mar 27, 17	15.3 to 16.7 (4)	8 16.1 E	....	....	....	....	5	....	C IV
			Mar 28, 17	9.5 to 10.6 (4)	8 11.6 E	....	....	....	....	5	....	C IV
			Mar 28, 17	11.1 to 14.3 (6)	8 18.0 E	....	....	....	....	25	....	C IV
			Oct 24, 17	15.1,17.5	8 13.8 E	....	....	15.7,17.0	.25416	5	....	C V
			Oct 25, 17	8.8,11.7	8 11.4 E	....	....	9.5,11.1	.25393	5	....	C V
			Oct 25, 17	12.2,15.9	8 13.3 E	....	....	14.1,15.4	.25377	5	....	C V
			Oct 26, 17	9.8,12.1	8 09.1 E	....	....	10.0,11.4	.25428	25	....	C V
			Oct 27, 17	8.4,11.2	8 08.6 E	....	....	8.9,10.5	.25425	25	....	C V
			Oct 29, 17	8.6,11.1	8 10.8 E	....	....	9.3,10.7	.25398	25	....	C V
			Nov 1, 17	....	....	10.2 to 15.8 (12)	25 39.2 S	....	....	......	EI 3	C V
			Nov 1, 17	....	....	16.9 (4)	25 43.2 S	....	....	......	EI 25	C V
			Nov 2, 17	....	....	15.4 (4)	25 41.2 S	....	....	......	EI 25	C V
			Nov 2, 17	....	....	16.6 (4)	25 42.7 S	....	....	......	EI 25	C V
			Nov 5, 17	9.5 to 13.3 (dv)	8 10.7 E	....	....	....	....	25	....	C V
			Nov 5, 17	14.6 to 17.6 (dv)	8 11.7 E	....	....	....	....	25	....	C V
Pilar, *F*	31 40.1 S	296 07	Mar 13, 17	9.7,15.0,15.9	8 16.3 E	....	....	10.8,14.5	.25410	5	....	C IV
			Mar 14, 17	8.8,11.5	8 13.2 E	....	....	9.4,11.0	.25452	5	....	C IV
			Mar 14, 17	14.0,16.6	8 20.0 E	....	....	14.5,16.0	.25452	5	....	C IV
			Mar 15, 17	8.7,11.5,12.0	8 13.2 E	....	....	9.4,11.0	.25458	25	....	C IV
			Mar 15, 17	14.0,16.5	8 19.3 E	....	....	14.6,16.0	.25447	25	....	C IV
			Mar 16, 17	8.7,11.3	8 12.1 E	....	....	9.2,10.8	.25470	25	....	C IV

SOUTH AMERICA.

ARGENTINA—*Continued.*

Station	Latitude	Long. East of Gr.	Date	Declination		Inclination		Hor. Intensity		Instruments		Obs'r
				Local Mean Time	Value	L. M. T.	Value	L. M. T.	Value	Mag'r	Dip Circle	
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Pilar, *F—Concluded*	31 40.1 S	296 07	Mar 16, '17	11.9	8 15.2 E	....	....	....	....	5	....	C IV
			Mar 17, 17	8.5 to 12.1 (dv)	8 12.3 E	....	....	....	....	25	....	C IV
			Mar 17, 17	14.0 to 16.3 (dv)	8 18.3 E	....	....	....	....	25	....	C IV
			Mar 19, 17	17.0	8 14.4 E	....	....	9.3,11.1	.25452	5	....	C IV
			Mar 19, 17	....	....	....	....	14.1,16.2	.25458	5	....	C IV
			Mar 20, 17	6.9 to 10.0 (dv)	8 09.9 E	....	....	....	....	5	....	C IV
			Mar 21, 17	6.4 to 9.1 (dv)	8 12.2 E	....	....	10.7,14.3	.25450	5	....	C IV
			Mar 22, 17	....	....	11.6,11.9	25 38.9 S	....	....	.....	EI 25	C IV
			Mar 22, 17	....	....	14.6,15.2	25 40.7 S	....	....	.....	EI 25	C IV
			Mar 22, 17	....	....	16.3 (4)	25 42.7 S	....	....	.....	EI 25	C IV
			Mar 23, 17	....	....	9.5 (4)	25 40.9 S	....	....	.....	EI 25	C IV
			Mar 23, 17	....	....	11.3 (3)	25 39.0 S	....	....	.....	EI 3	C IV
			Mar 23, 17	....	....	14.9 (5)	25 42.8 S	....	....	.....	EI 3	C IV
			Mar 23, 17	....	....	16.4 (4)	25 44.5 S	....	....	.....	EI 3	C IV
			Mar 26, 17	15.3 to 17.9 (dv)	8 16.4 E	....	....	....	....	25	....	C IV
			Mar 27, 17	15.3 to 16.7 (4)	8 17.1 E	....	....	....	....	25	....	C IV
			Mar 28, 17	9.5 to 10.6 (4)	8 11.8 E	....	....	....	....	25	....	C IV
			Mar 28, 17	11.1 to 14.3 (6)	8 18.7 E	....	....	....	....	5	....	C IV
			Mar 28, 17	15.0 to 16.1 (dv)	8 19.7 E	....	....	....	....	25	....	C IV
			Mar 29, 17	....	....	13.8,14.2	25 39.2 S	15.0	.25457	25	EI 25	C IV
			Mar 29, 17	....	....	16.0,16.3	25 42.6 S	....	....	.....	EI 25	C IV
			Mar 30, 17	....	....	9.6 to 15.6 (8)	25 39.9 S	10.6,14.7	.25458	25	EI 25	C IV
			Apr 2, 17	8.9,10.6	8 12.0 E	....	....	9.4,10.2	.25436	5	....	C IV
			Apr 2, 17	12.2,13.8	8 18.6 E	....	....	11.1,11.9	.25452	5	....	C IV
			Apr 2, 17	15.2 to 17.7 (dv)	8 17.8 E	....	....	....	....	5	....	C IV
			Apr 3, 17	....	....	9.4 to 16.7 (5)	25 41.9 S	10.1	.25438	25	EI 25	C IV
			Apr 3, 17	....	....	....	....	14.6,15.9	.25402	25	....	C IV
			Oct 24, 17	15.1,17.5	8 13.4 E	....	....	15.7,17.0	.25401	25	....	C V
			Oct 25, 17	8.8,11.7	8 11.0 E	....	....	9.4,11.1	.25376	25	....	C V
			Oct 25, 17	12.2,15.9	8 12.8 E	....	....	14.1,15.4	.25386	25	....	C V
			Oct 26, 17	5.6 to 8.3 (dv)	8 07.3 E	....	....	....	....	25	....	C V
			Oct 26, 17	9.3,12.1	8 09.8 E	....	....	10.0,11.5	.25422	5	....	C V
			Oct 26, 17	15.3 to 18.3 (dv)	8 10.2 E	....	....	....	....	25	....	C V
			Oct 27, 17	8.4,11.2	8 09.7 E	....	....	9.0,10.5	.25432	5	....	C V
			Oct 29, 17	8.6,11.1	8 11.4 E	....	....	9.3,10.7	.25384	5	....	C V
			Oct 29, 17	....	....	....	....	13.7 to 17.5 (6)	.25362	25	....	C V
			Oct 30, 17	....	....	12.1 (4)	25 38.6 S	9.0, 9.8	.25414	25	EI 25	C V
			Oct 30, 17	....	....	16.9 (4)	25 45.2 S	14.9,15.8	.25385	25	EI 25	C V
			Oct 31, 17	....	....	8.4, 8.8	25 40.5 S	9.8,10.9	.25445	25	EI 25	C V
			Oct 31, 17	....	....	12.7 (3)	25 35.2 S	....	....	.....	EI 25	C V
			Nov 1, 17	....	....	10.2 to 15.8 (12)	25 39.1 S	....	....	.....	EI 25	C V
			Nov 1, 17	....	....	16.9 (4)	25 44.2 S	....	....	.....	EI 3	C V
			Nov 2, 17	....	....	9.1, 9.6	25 40.0 S	10.6,10.9	.25470	25	EI 25	C V
			Nov 2, 17	....	....	12.1 (3)	25 36.3 S	....	....	.....	EI 25	C V
			Nov 2, 17	....	....	15.4 (4)	25 41.6 S	....	....	.....	EI 3	C V
			Nov 2, 17	....	....	16.6 (4)	25 43.2 S	....	....	.....	EI 3	C V
Villa Dolores	31 57.3 S	294 47	Jun 23, 17	9.9,12.8	9 17.8 E	14.5 (3)	26 24.9 S	10.4,12.0	.25577	25	EI 25	LLT
Villa Maria	32 24.8 S	296 47	Jul 17, 17	9.8,12.7	7 56.6 E	14.2,14.5	26 15.4 S	10.4,11.5	.25326	25	EI 25	LLT
Leones	32 39.4 S	297 41	Jul 15, 17	9.7,12.5	7 21.8 E	15.2,15.5	26 33.1 S	10.3,11.4	.25128	25	EI 25	LLT
Uspallata	32 40.8 S	290 36	Jun 16, 17	9.7,11.6	12 30.4 E	14.4,14.7	28 57.5 S	10.2,11.3	.26105	25	EI 25	LLT
Cañada de Gomez	32 49.2 S	298 38	Jul 13, 17	10.4,12.8	6 43.2 E	14.4,14.6	26 36.4 S	10.8,12.1	.24952	25	EI 25	LLT
Puente del Inca	32 49.7 S	290 04	Jun 12, 17	9.7,11.8	12 27.0 E	15.7,16.0	28 59.6 S	10.2,11.4	.26034	25	EI 25	P&T
Mendoza	32 53.6 S	291 08	Jun 5, 17	9.9,12.6	11 52.6 E	14.4,14.7	29 07.0 S	10.5,12.0	.25940	25	EI 25	P&T
Rosario	32 56.4 S	299 22	Jul 12, 17	13.7,17.1	6 12.4 E	11.5,11.7	26 16.6 S	14.2,16.6	.24923	25	EI 25	LLT
Rio Cuarto	33 08.0 S	295 38	Jul 19, 17	9.9,12.5	9 02.4 E	14.5,14.8	27 41.0 S	10.5,12.5	.25432	25	EI 25	LLT
San Luis	33 17.8 S	293 38	Jun 19, 17	10.0,12.7	10 28.0 E	14.4,14.6	28 22.5 S	10.5,12.0	.25698	25	EI 25	P&T
Las Catitas	33 18.3 S	291 57	Jun 4, 17	9.6,11.6	11 28.6 E	13.8,14.3	29 12.8 S	10.1,11.2	.25815	25	EI 25	P&T
Villa Mercedes	33 39.1 S	294 31	Jun 21, 17	9.8,11.6	10 00.0 E	13.6,13.9	28 29.1 S	10.2,11.2	.25538	25	EI 25	LLT
Pergamino	33 55.1 S	299 25	Jul 11, 17	10.0,12.9	6 22.4 E	15.1,15.3	27 33.8 S	10.6,12.1	.24964	25	EI 25	LLT
Mackenna	33 55.6 S	295 36	Jun 28, 17	9.7,11.5	9 10.9 E	13.5,13.7	28 36.2 S	10.2,11.1	.25452	25	EI 25	P&T
Rufino	34 16.2 S	297 16	Jun 29, 17	10.8,15.0	8 11.9 E	16.6,16.7	28 25.6 S	13.4,14.6	.25264	25	EI 25	P&T
Florida, *A*	34 32.1 S	301 30	Feb 2, 20	10.9,13.8	4 39.6 E	....	....	11.6,13.4	.24579	5	....	CVI
			Feb 2, 20	14.8,16.6	4 37.4 E	....	....	15.2,16.1	.24582	5	....	CVI
			Feb 3, 20	10.0,11.9	4 38.8 E	....	....	10.5,11.4	.24616	25	....	CVI
			Feb 3, 20	13.4,14.8	4 40.4 E	....	....	13.8,14.5	.24627	25	....	CVI
			Feb 3, 20	16.1 to 17.4 (dv)	4 39.3 E	....	....	....	....	25	....	CVI
			Feb 4, 20	....	....	....	....	10.2,10.7	.24617	5	....	CVI
			Feb 5, 20	....	....	10.8,11.1	27 50.1 S	....	....	.....	EI 7	CVI

SOUTH AMERICA.

ARGENTINA—*Concluded.*

Station	Latitude	Long. East of Gr.	Date	Declination		Inclination		Hor. Intensity		Instruments		Obs'r
				Local Mean Time	Value	L. M. T.	Value	L. M. T.	Value	Mag'r	Dip Circle	
	° ′	° ′		*h h h*	° ′	*h h*	° ′	*h h*	*c. g. s.*			
Florida, *A*—*Concluded*	34 32.1 S	301 30	Feb 5, '20	....	....	11.6,11.9	27 50.5 S	....	....	......	EI 25	C VI
			Feb 9, 20	18.5	4 39.3 E	....	....	....	....	25	....	C VI
Florida, *B*	34 32.1 S	301 30	Feb 2, 20	10.9,13.8	4 39.0 E	....	....	11.6,13.4	.24580	25	....	C VI
			Feb 2, 20	14.8,16.6	4 37.0 E	....	....	15.2,16.0	.24584	25	....	C VI
			Feb 3, 20	10.0,11.9	4 37.7 E	....	....	10.5,11.4	.24620	5	....	C VI
			Feb 3, 20	13.4,14.8	4 39.5 E	....	....	13.8,14.5	.24629	5	....	C VI
			Feb 4, 20	....	....	13.2,13.8	27 54.4 S	10.2,10.7	.24614	25	EI 25	C VI
			Feb 4, 20	....	....	15.6,15.9	27 55.6 S	14.5,15.0	.24600	25	EI 25	C VI
			Feb 5, 20	....	....	10.8,11.1	27 50.6 S	....	....	......	EI 25	C VI
			Feb 5, 20	....	....	11.6,11.9	27 50.6 S	....	....	......	EI 7	C VI
			Feb 5, 20	....	....	13.1,14.8	27 51.8 S	13.8,14.4	.24617	25	EI 25	C VI
			Feb 6, 20	....	....	....	....	10.0,11.1	.24615	25	....	C VI
			Feb 6, 20	....	....	....	....	12.0,13.8	.24636	25	....	C VI
			Feb 6, 20	....	....	....	....	14.5,15.8	.24632	25	....	C VI
			Feb 7, 20	....	....	10.0,11.3	27 52.3 S	10.7,11.8	.24596	25	EI 25	C VI
			Feb 7, 20	....	....	11.5,12.3	27 51.2 S	....	....	......	EI 25	C VI
Junin	34 34.4 S	299 03	Jun 30, 17	13.1,15.2	6 58.4 E	11.0,11.2	28 20.4 S	13.7,14.8	.25094	25	EI 25	P&T
San Rafael	34 36.5 S	291 37	Jun 2, 17	10.1,12.7	12 06.4 E	15.5,15.7	30 37.1 S	10.5,12.0	.25922	25	EI 25	P&T
Mercedes	34 40.3 S	300 33	Jul 2, 17	9.7,12.4	5 45.3 E	14.0,14.3	28 09.0 S	10.3,11.4	.24904	25	EI 25	P&T
			Jul 25, 19	12.3,14.5	5 30.6 E	15.4	28 08.8 S	12.9,14.1	.24759	16	242.12	AS
			Sep 2, 19	16.4	5 27.9 E	....	....	....	....	16	....	AS
			Sep 3, 19	8.7 to 16.9 (dv)	5 27.6 E	....	....	....	....	16	....	AS
Buena Esperanza	34 45.8 S	294 45	May 31, 17	10.7,13.3	10 08.5 E	14.9,15.2	29 42.6 S	11.2,12.9	.25548	25	EI 25	P&T
Navia	34 46.8 S	293 26	May 29, 17	....	....	14.8,15.1	30 22.6 S	....	....	......	EI 25	P&T
			May 30, 17	11.1,14.7	10 58.2 E	....	....	12.1,14.2	.25644	25	....	P&T
Las Flores	36 02.9 S	300 52	May 18, 17	10.2,13.6	5 57.4 E	15.2,16.0	29 55.4 S	11.2,13.3	.24845	25	EI 25	P&T
			Nov 15, 17	10.5,11.0	5 54.6 E	....	....	....	....	25	....	LLT
Olavarria	36 53.8 S	299 40	May 16, 17	10.4,12.3	7 14.6 E	13.7,13.9	30 50.0 S	10.8,11.5	.24996	25	EI 25	P&T
General La Madrid	37 15.7 S	298 44	May 15, 17	10.3,11.7	7 54.4 E	14.8,15.0	31 32.0 S	10.7,11.4	.25212	25	EI 25	P&T
Saavedra	37 46.2 S	297 39	May 13, 17	11.2,14.1,15.8	9 00.1 E	10.8,11.0	32 20.2 S	14.6,15.5	.25302	25	EI 25	P&T
Bahia Blanca	38 46.7 S	297 44	May 11, 17	10.4,12.7	9 06.5 E	14.2,14.5	33 24.0 S	10.8,11.6	.25356	25	EI 25	P&T
			Jul 31, 19	10.6,13.1	8 49.4 E	14.4	33 19.5 S	11.0,11.7	.25236	16	242.156	AS
Pichi-Mahuida	38 50.3 S	295 03	May 4, 17	....	....	16.5,16.9	34 00.8 S	....	....	......	EI 25	P&T
			May 5, 17	9.7,13.8	11 09.8 E	....	....	10.6,13.4	.25621	25	....	P&T
Zapala	38 55.2 S	289 56	Apr 28, 17	10.5,12.8	14 17.4 E	14.8,15.1	35 55.6 S	11.1,12.1	.26243	25	EI 25	ADP
			Aug 4, 19	10.0,11.5	14 07.0 E	14.1	35 45.7 S	10.6	.26113	16	242.1256	AS
Cipolletti	38 56.3 S	292 00	Apr 30, 17	10.2,12.5	13 04.6 E	14.9,15.1	35 06.3 S	10.8,12.0	.26050	25	EI 25	ADP
			Aug 6, 19	11.2	12 48.5 E	....	....	11.6,14.4	.25939	16	....	AS
			Aug 7, 19	8.3 to 16.7 (dv)	12 51.5 E	....	....	....	....	16	....	AS
			Aug 8, 19	10.9	12 50.0 E	14.2	34 57.2 S	....	....	16	242.1256	AS
Rio Colorado	38 59.5 S	295 54	May 8, 17	9.5,12.5	10 31.8 E	15.0,15.7	34 17.4 S	....	....	25	EI 25	P&T
			May 9, 17	....	....	....	....	9.3,10.8	.25547	25	....	P&T
Chelforo	39 06.1 S	293 28	May 3, 17	10.3,12.7	12 13.8 E	14.6,15.0	35 06.4 S	10.9,12.0	.25882	25	EI 25	ADP
Valcheta	40 41 S	293 51	Aug 22, 19	9.7,10.8	11 58.4 E	11.6	36 37.0 S	10.1	.25637	16	242.12	AS
San Antonio	40 43.5 S	295 06	Aug 24, 19	10.3,11.9	11 46.7 E	14.2	36 07.1 S	10.7,11.5	.25642	16	242.126	AS
Patagones	40 47.7 S	297 01	Aug 15, 19	10.5,13.2	10 14.4 E	14.4	35 34.2 S	10.9,11.7	.25417	16	242.1256	AS
Huahuel Niyeu	41 19.4 S	290 28	Aug 20, 19	10.6,14.0	14 28.5 E	16.1	38 04.6 S	11.2,13.6	.26254	16	242.12	AS
Puerto Madryn	42 45.8 S	294 58	Jun 20, 19	11.2,12.7	12 14.2 E	14.2	38 07.8 S	11.5,12.4	.25788	16	242.1256	AS
Dolavon	43 18.1 S	294 17	Jun 23, 19	12.8,14.4	12 44.2 E	16.1	38 51.3 S	13.2,14.0	.25983	16	242.12	AS
			Jun 24, 19	9.1 to 16.4 (dv)	12 42.7 E	....	....	....	....	16	....	AS
Parada Kilometro 163	45 47.3 S	291 14	Jun 11, 19	10.0,11.5	15 24.2 E	14.1	42 08.3 S	10.4,11.1	.26507	16	242.1256	AS
Comodoro Rivadavia	45 51.0 S	292 31	Jun 15, 19	10.1,11.6	14 10.2 E	13.5	41 49.2 S	10.5,11.2	.26419	16	242.1256	AS
Las Mesetas	46 13 S	290 27	Jun 8, 19	13.6,14.7	15 57.8 E	....	....	14.0	.26651	16	....	AS
			Jun 9, 19	....	....	14.5	42 41.2 S	11.0	.26600	16	242.1256	AS
Colonia Las Heras	46 34 S	291 09	Jun 6, 19	10.5,13.0	15 26.6 E	14.2	42 46.3 S	10.9,12.5	.26593	16	242.256	AS
Puerto Deseado	47 44.6 S	294 05	May 28, 19	6.1 to 12.3 (dv)	14 10.7 E	....	....	....	....	16	....	AS
			May 29, 19	5.1 to 12.3 (dv)	14 10.2 E	....	....	....	....	16	....	AS
			May 30, 19	6.2 to 12.3 (dv)	14 10.0 E	....	....	....	....	16	....	AS
			May 31, 19	13.8,15.4	14 12.5 E	....	....	14.2,15.0	.26328	16	....	AS
			Jun 1, 19	....	....	12.0	43 44.5 S	....	....	......	242.125	AS
Mata Grande	48 50.8 S	292 27	May 18, 19	9.4,11.4	15 53 8 E	15.2	44 50.2 S	9.9,11.0	.26620	16	242.56	AS
			May 20 19	9.3 to 16.1 (dv)	15 53.5 E	....	....	....	....	16	....	AS
San Julian	49 15.1 S	292 22	May 1, 19	13.9,15.8	15 52.6 E	....	....	14.4,15.4	.26650	16	....	AS
			May 3, 19	....	....	14.3	45 17.0 S	....	....	......	242.256	AS
Santa Cruz	50 00.9 S	291 30	Apr 26, 19	9.2, 9.4	16 14.5 E	13.1	46 04.1 S	11.2	.26760	16	242.56	AS
Rio Gallegos	51 36.5 S	290 50	Apr 22, 19	11.1,14.1	17 06.0 E	15.4	47 47.9 S	11.4,13.6	.26836	16	242.1256	AS

SOUTH AMERICA.

BOLIVIA.

Station	Latitude	Long. East of Gr.	Date	Declination		Inclination		Hor. Intensity		Instruments		Obs'r
				Local Mean Time	Value	L. M. T.	Value	L. M. T.	Value	Mag'r	Dip Circle	
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Guayara Mirim..........	10 48.0 S	294 37	Sep 15, '14	13.7,14.7	4 01.5 E	16.3	6 43.6 N	14.0,14.5	.28742	19	19.56	HRS
			Oct 10, 17	9.8,11.9	3 35.2 E	14.6	7 12.5 N	10.3,11.4	.28815	21	21.12	AS
Riberalta..............	11 00.0 S	293 55	Sep 28, 17	9.6,11.7	3 57.0 E	15.2	6 24.8 N	10.1,11.1	.29388	21	21.12(6)	AS
Copacabana............	11 32.2 S	293 14	Sep 15, 17	8.1,10.2	4 10.6 E	15.0	4 20.5 N	8.6, 9.6	.28956	21	21.12(6)	AS
			Sep 16, 17	7.2 to 17.5 (dv)	4 11.5 E	....	....	....	....	21	....	AS
Mamoré 11.............	11 40.3 S	294 46	Sep 10, 14	15.0,15.9	3 51.4 E	12.7	4 40.0 N	15.3,15.7	.28458	19	19.56	HRS
San Luis...............	12 32.3 S	293 00	Sep 6, 17	15.6	4 42.8 E	....	....	16.1	.28540	21	....	AS
			Sep 7, 17	7.1 to 17.4 (dv)	4 42.9 E	....	....	....	....	21	....	AS
			Sep 8, 17	9.5	4 40.4 E	10.8	3 19.4 N	9.1	.28631	21	21.12(3(6)	AS
Guaporé 7 (Mategua).....	13 01.2 S	297 14	Aug 27, 14	10.6,11.6	2 48.8 E	14.1	3 04.2 N	10.9,11.4	.28128	19	19.56	HRS
Muque..................	13 10.5 S	292 40	Aug 31, 17	10.7,16.1	5 00.8 E	8.4	1 00.6 N	11.2,15.7	.28631	21	21.12(3(6)	AS
Guaporé 5..............	13 33.8 S	298 31	Aug 16, 14	8.3 to 16.9 (dv)	2 06.2 E	....	....	....	....	19	....	HRS
			Aug 17, 14	10.5,11.6	2 03.2 E	14.7	2 21.7 N	10.8,11.4	.27809	19	19.256	HRS
Guaporé 3..............	13 44.9 S	299 22	Aug 8, 14	12.0,14.1	1 33.1 E	15.9	1 37.6 N	13.3,13.8	.27804	19	19.256	HRS
Tarene.................	13 47.6 S	292 23	Aug 25, 17	8.8,10.8	5 24.8 E	15.0	0 01.0 S	9.2,10.3	.28332	21	21.12(6)	AS
Rurrenabaque...........	14 26.5 S	292 19	Aug 5, 17	9.8,11.7	5 33.4 E	14.8	0 47.2 S	10.4,11.3	.28344	21	21.12(3)	AS
			Aug 7, 17	....	....	11.7	0 41.3 S	....	....	......	21.12(3)	AS
			Aug 10, 17	7.8 to 17.8 (dv)	5 34.5 E	....	....	....	....	21	....	AS
Guanay.................	15 30.1 S	291 55	Jul 27, 17	10.1	6 06.1 E	....	....	13.1,14.2	.28281	21	....	AS
			Jul 28, 17	10.2	6 08.6 E	12.1	2 45.4 S	....	....	21	21.12(3)	AS
Sorata.................	15 46.3 S	299 12	Jul 7, 17	10.7,16.2	6 32.5 E	17.0	3 33.6 S	11.1,12.0	.28249	21	21.12	AS
			Jul 9, 17	....	....	10.6	3 29.0 S	....	....	......	21.12(3)	AS
			Jul 14, 17	16.4 to								
			Jul 15, 17	16.8 (dv).......	6 32.9 E	....	....	....	....	21	....	AS
La Paz, *1912*..........	16 30.8 S	291 49	Apr 15, 14	9.9 to 17.0 (dv)	6 55.0 E	....	....	....	....	19	....	HRS
			Apr 19, 14	10.2,11.8	6 51.8 E	13.6	4 51.4 S	10.7,11.6	.27958	19	19.256	HRS
La Paz, *1917*..........	16 30.8 S	291 47	Jun 4, 17	....	....	16.6	4 26.5 S	....	....	......	21.12(13)[1]	AS
			Jun 5, 17	....	....	10.0	4 23.4 S	....	....	......	21.12(13)[1]	AS
			Jun 5, 17	....	....	12.7,14.9	4 23.6 S	....	....	......	21.12(56)[2]	AS
			Jun 6, 17	....	....	9.8,13.4	4 21.0 S	....	....	......	21.(13)56)[3]	AS
			Jun 8, 17	16.1 to								
			Jun 9, 17	16.2 (dv).......	6 30.0 E	....	....	....	....	21	....	AS
			Jun 9, 17	16.5	6 29.9 E	....	....	....	....	21	....	AS
			Jun 10, 17	16.7	6 28.6 E	....	....	17.1	.27916	21	....	AS
			Jun 11, 17	11.1	6 32.6 E	12.3	4 20.6 S	10.7	.28019	21	21.(13)56)[3]	AS
Corocoro...............	17 13.4 S	291 29	Apr 11, 14	14.7,16.0	7 20.9 E	12.9	6 24.4 S	15.1,15.7	.27822	19	19.256	HRS
Cochabamba	17 24.2 S	293 40	May 2, 14	9.6 to 17.2 (dv)	6 00.1 E	....	....	....	....	19	....	HRS
			May 3, 14	8.8,10.2	5 56.9 E	12.1	5 25.3 S	9.2, 9.9	.27478	19	19.256	HRS
Motacusito.............	17 34.6 S	298 14	Jun 1, 14	8.0 to 17.2 (dv)	2 57.6 E	....	....	....	....	19	....	HRS
			Jun 2, 14	9.2,11.5	2 57.0 E	14.2	4 33.3 S	9.6,11.2	.26914	19	19.256	HRS
Vacas..................	17 34.8 S	294 10	May 7, 14	10.1,11.4	5 40.4 E	14.0	5 44.6 S	10.5,11.2	.27470	19	19.256	HRS
Tres Cruces............	17 35.8 S	297 25	May 28, 14	16.4,17.4	3 35.5 E	....	....	16.7,17.2	.26999	19	....	HRS
			May 29, 14	....	....	12.3	4 28.1 S	....	....	......	19.256	HRS
Rio Grande.............	17 40.4 S	296 51	May 26, 14	12.9,14.2	3 54.9 E	16.0	5 01.2 S	13.2,13.9	.27071	19	19.256	HRS
Totora.................	17 44.7 S	294 30	May 9, 14	10.4,11.6	5 28.6 E	14.3,15.6[4]	5 50.0 S	10.7,11.3	.27414	19	19.256	HRS
Santa Cruz.............	17 47.2 S	296 26	May 23, 14	14.7,15.7	4 15.4 E	12.5	5 13.8 S	15.0,15.5	.27121	19	19.56	HRS
San José...............	17 50.8 S	299 01	Jun 6, 14	12.4,13.4	2 35.1 E	14.5	4 41.3 S	12.7,13.2	.26854	19	19.256	HRS
Oruro..................	17 59.1 S	292 53	Apr 26, 14	10.7,11.8	6 40.5 E	14.2	6 54.3 S	11.0,11.5	.27746	19	19.256	HRS
Puquina................	18 02.6 S	295 14	May 13, 14	10.2,11.4	5 05.6 E	14.2	6 04.4 S	10.6,11.2	.27289	19	19.256	HRS
			May 14, 14	6.6 to 17.2 (dv)	5 06.1 E	....	....	....	....	19	....	HRS
Ipias..................	18 02.9 S	299 37	Jun 9, 14	10.6,12.3	2 22.9 E	14.5	4 49.3 S	11.0,11.6	.26805	19	19.256	HRS
Samaipata..............	18 10.9 S	295 28	May 17, 14	10.2,11.5	4 46.6 E	14.3	6 09.0 S	10.7,11.2	.27171	19	19.56	HRS
Santiago...............	18 20.7 S	300 04	Jun 12, 14	10.0,11.2	1 51.4 E	14.3	5 16.6 S	10.3,10.9	.26720	19	19.56	HRS
Tucabaca...............	18 36.2 S	300 56	Jun 15, 14	9.3 to 11.6 (dv)	1 20.7 E	....	....	16.4,16.9	.26532	19	....	HRS
			Jun 15, 14	16.2,17.1	1 20.6 E	....	....	....	....	19	....	HRS
			Jun 16, 14	....	....	9.3	5 36.2 S	....	....	......	19.256	HRS
Yacuses................	18 58.7 S	301 42	Jun 18, 14	16.4,17.6	1 05.6 E	....	....	16.8,17.4	.26466	19	....	HRS
			Jun 19, 14	....	....	10.3	6 13.6 S	....	....	......	19.56	HRS
Uyuni..................	20 28.0 S	293 11	May 23, 14	13.4,14.6	6 48 3 E	12.1	10 38.2 S	13.9	.27033	21	21.(3(6)	AS

[1] Needles No. 1 and No. 3 of universal magnetometer 19.
[2] Needles No. 5 and No. 6 of universal magnetometer 20.
[3] Needles No. 1 and No. 3 of universal magnetometer 19 and needles No. 5 and No. 6 of universal magnetometer 20.
[4] Needle No. 2 only at 15.6*h*.

SOUTH AMERICA.

BRAZIL.

Station	Latitude	Long. East of Gr.	Date	Declination: Local Mean Time	Declination: Value	Inclination: L. M. T.	Inclination: Value	Hor. Intensity: L. M. T.	Hor. Intensity: Value	Instruments: Mag'r	Instruments: Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Bragança	1 03.7 S	313 14	May 1, '18	10.6,15.1	10 44.3 W	16.6	22 39.8 N	11.9,14.7	.28848	21	21.12	AS
Timboteua	1 12.4 S	312 36	May 2, 18	13.0,14.8	10 31.5 W	....	....	13.4,14.3	.28979	21	....	AS
			May 3, 18	....	....	9.9	22 29.8 N	....	....	....	21.12(3(6)	AS
Pinheiro, *A*	1 17.9 S	311 31	Oct 1, 14	8.8,10.3	8 53.6 W	11.3	22 57.9 N	9.3,10.0	.29121	21	21.(343)	ADP
			Oct 29, 14	13.6,14.8	8 51.6 W	16.0	22 56.6 N	13.9,14.5	.29067	19	19.56	HRS
			Sep 3, 15	14.2,15.6	9 05.3 W	....	....	14.6,15.2	.29122	19	....	DWB
			Sep 4, 15	7.5	9 02.4 W	8.6	22 57.5 N	....	....	19	19.(12)	DWB
			Apr 12, 18	10.2,14.5	9 36.4 W	16.3	22 53.0 N	10.7,11.5	.29138	21	21.12(3(6)	AS
			Apr 13, 18	7.9 to 16.5 (dv)	9 37.7 W	....	....	....	....	21	....	AS
			Apr 20, 18	16.4	9 38.7 W	....	....	....	....	21	....	AS
			May 9, 18	8.3 to 17.1 (dv)	9 39.5 W	....	....	....	....	21	....	AS
			May 10, 18	8.4	9 36.1 W	....	....	....	....	21	....	AS
			Jul 18, 19	8.7,10.3	9 46.2 W	11.3,11.6	22 47.9 N	9.1, 9.9	.29126	28	EI 28	DMW
Pinheiro, *B*	1 17.9 S	311 31	Jul 18, 19	14.5,16.0	9 53.3 W	13.7,13.9	22 49.8 N	14.9,15.7	.29113	28	EI 28	DMW
Castanhal	1 17.9 S	312 05	Apr 26, 18	9.4,12.6	9 54.6 W	13.5	22 34.8 N	9.9,10.9	.29034	21	21.12	AS
Almeirim	1 32.0 S	307 26	Apr 5, 18	9.9,11.7	6 47.4 W	14.7	23 21.2 N	10.4,11.3	.29224	21	21.12(3(6)	AS
Obidos	1 55.8 S	304 32	Feb 12, 18	10.6,13.8	4 46.2 W	15.0	23 07.2 N	11.2,12.1	.29262	21	21.12(3(6)	AS
Cameta	2 15.2 S	310 30	Aug 28, 15	17.1	8 16.6 W	17.7	21 35.2 N	....	....	19	19.(12)	DWB
			Aug 29, 15	7.6	8 15.6 W	....	....	8.0, 8.6	.28966	19	....	DWB
Santarem	2 24.9 S	305 21	Feb 16, 18	15.3,17.2	5 13.3 W	....	....	15.8,16.8	.29131	21	....	AS
			Feb 17, 18	....	....	15.6	22 17.6 N	....	....	....	21.12(3)	AS
Putumayo 4	2 52.5 S	290 27	Sep 11, 14	13.3,15.1	3 58.3 E	16.9	18 28.6 N	13.8,14.7	.30615	21	21.(33)4)	ADP
Amarração	2 52.9 S	318 21	Jun 22, 19	14.5,16.0	14 06.0 W	13.6,13.9	16 47.6 N	14.9,15.7	.28881	28	EI 28	DMW
Camocim	2 54.0 S	319 09	May 8, 19	9.1,10.5	14 32.0 W	15.2,15.5	16 05.0 N	9.5,10.2	.28788	28	EI 28	DMW
Putumayo 5	2 58.5 S	291 02	Sep 14, 14	9.2,10.8	3 55.2 E	13.0	18 33.2 N	9.7,10.5	.30418	21	21.(343)4)	ADP
São Joachim	3 02.2 S	310 20	Aug 23, 15	8.3, 9.5	8 01.0 W	10.9	20 14.4 N	8.7, 9.2	.28963	19	19.(12)	DWB
Santo Antonio do Iça	3 06.2 S	292 00	Sep 17, 14	15.8,17.4	3 30.1 E	....	....	16.2,17.1	.30234	21	....	ADP
			Sep 18, 14	....	....	10.6	18 50.8 N	....	....	....	21.(343)4)	ADP
Manaos, *II**	3 07.6 S	299 58	Sep 25, 14	10.4,12.6	0 49.6 W	14.8	20 45.9 N	11.1,12.1	.29534	21	21.(343)4)	ADP
Manaos, *I*	3 08.5 S	300 00	Oct 19, 14	13.4,14.5	0 48.6 W	16.7	20 42.0 N	13.7,14.3	.29519	19	19.56	HRS
			Nov 6, 17	9.6,11.5	1 22.6 W	13.8	20 59.0 N	10.1,11.1	.29564	21	21.12(3)	AS
			Nov 8, 17	7.4 to 16.9 (dv)	1 24.1 W	....	....	....	....	21	....	AS
			Feb 2, 18	9.5,11.8	1 23.4 W	12.4	21 02.4 N	10.0,11.0	.29530	21	21.12	AS
São Juaquim	3 31.6 S	301 04	Oct 13, 14	8.8, 9.8	1 28.2 W	10.7	20 12.2 N	9.0, 9.5	.29344	19	19.56	HRS
Bocca do Purus	3 39.9 S	298 35	Nov 22, 17	10.1,14.4	0 26.2 W	15.6	20 24.4 N	10.6,13.6	.29404	21	21.12(3(6)	AS
Sobral, *Eclipse*	3 41.6 S	319 39	May 21, 19	....	....	17.5,17.7	14 30.9 N	....	....	....	EI 28	DMW
			May 22, 19	15.6,18.0	14 57.0 W	10.1,10.3	14 27.0 N	16.3,17.6	.28726	28	EI 28	DMW
			May 24, 19	7.8, 9.5	14 55.4 W	10.4,11.1	14 29.0 N	8.2, 9.1	.28709	28	EI 28	DMW
			May 25, 19	....	....	....	....	6.8,17.6	.28723	28	....	DMW
			May 25, 19	....	....	....	....	7.8 to 16.8 (12)	.28727	28	....	DMW
			May 26, 19	16.7,18.0	14 58.8 W	16.1,16.3	14 32.9 N	17.0,17.7	.28658	28	EI 28	DMW
			May 28, 19	16.6,17.9	14 56.6 W	15.7,15.8	14 30.8 N	16.9,17.6	.28712	28	EI 28	DMW
			May 29, 19	7.1 to 14.0 (dv)	14 55.7 W	17.7,17.8	14 28.2 N	16.2,17.0	.28729	28	EI 28	DMW
			May 30, 19	....	....	....	....	7.1	.28741	28	....	DMW
			May 30, 19	....	....	....	....	8.5 to 18.0 (10)	.28739	28	....	DMW
			Jun 1, 19	9.1,10.0	14 55.2 W	7.7, 7.9	14 26.6 N	9.4	.28795	28	EI 28	DMW
			Jun 6, 19	....	....	15.9,16.1	14 28.5 N	17.1,17.8	.28740	28	EI 28	DMW
			Jun 7, 19	9.2, 9.4	14 53.3 W	....	....	....	....	28	....	DMW
			Jun 9, 19	8.8,10.4	14 52.8 W	8.1, 8.3	14 27.0 N	9.2,10.1	.28783	28	EI 28	DMW
Fortaleza	3 43.3 S	321 30	Apr 29, 19	13.5,15.0	16 23.8 W	15.7,16.0	13 28.5 N	13.9,14.6	.29211	28	EI 28	DMW
Alcobaça	3 45.6 S	310 19	Aug 19, 15	15.8,16.0	8 01.0 W	16.7	19 07.1 N	....	....	19	19.(2)	DWB
			Aug 20, 15	8.9,10.2,14.4	8 01.2 W	....	....	9.2, 9.8	.28724	19	....	DWB
Urucurituba	3 48.2 S	304 25	Mar 20, 18	10.4,14.1	4 30.7 W	15.2	20 08.3 N	10.9,11.8	.28867	21	21.12(3(6)	AS
Perseverança	4 05.2 S	300 38	Oct 11, 14	7.7, 8.7	1 00.8 W	10.7	18 52.9 N	8.0, 8.4	.29324	19	19.56	HRS
San Luiz	4 27.2 S	303 50	Feb 22, 18	10.7,15.3	3 48.2 W	....	....	11.4,14.9	.28922	21	....	AS
			Mar 16, 18	....	....	15.7	19 12.0 N	....	....	....	21.12(3(6)	AS
			Mar 17, 18	7.6 to 17.6 (dv)	3 49.2 W	....	....	....	....	21	....	AS
Itaboca	4 28.9 S	310 27	Aug 8, 15	9.2,10.3	7 55.2 W	11.4	17 55.6 N	9.5,10.0	.28677	19	19.(12)	DWB
Nova-Russas	4 42.5 S	319 27	Jun 12, 19	15.0,16.8	14 45.4 W	....	....	15.6,16.5	.28507	28	....	DMW
			Jun 13, 19	....	....	8.2, 8.3	12 41.4 N	....	....	....	EI 28	DMW
Aruma	4 43.8 S	297 54	Dec 3, 17	8.6,10.7	0 09.8 E	13.4	17 37.4 N	9.2,10.3	.29607	21	21.12	AS
Vista Alegre	4 53.9 S	299 56	Oct 8, 14	16.0,17.0	0 28.4 W	....	....	16.3,16.7	.29066	19	....	HRS
			Oct 9, 14	....	....	10.5,12.9	17 37.7 N	....	....	....	19.56	HRS
Quixada	4 58.4 S	321 00	Apr 23, 19	9.9,11.6	15 37.2 W	9.0, 9.2	11 09.9 N	10.4,11.1	.28476	28	EI 28	DMW
Guajaratuba	5 00.6 S	297 04	Nov 27, 17	13.6,13.9	0 46.8 E	16.3	17 23.0 N	....	....	21	21.12(3(6)	AS
			Nov 28, 17	15.2	0 45.4 E	....	....	15.6,16.6	.29280	21	....	AS
			Dec 1, 17	8.8 to 17.5 (dv)	0 46.2 E	....	....	....	....	21	....	AS
Maraba	5 20.9 S	310 49	Aug 2, 15	13.9,15.1	8 10.5 W	15.7	16 14.4 N	14.3,14.8	.28562	19	19.(12)	DWB
Espinhel	5 33.5 S	311 42	Jul 30, 15	6.5, 8.0	8 43.0 W	9.1	15 38.4 N	7.0, 7.6	.28508	19	19.(12)	DWB

* Local disturbance.

SOUTH AMERICA.

BRAZIL—*Continued.*

Station	Latitude	Long. East of Gr.	Date	Declination: Local Mean Time	Declination: Value	Inclination: L. M. T.	Inclination: Value	Hor. Intensity: L. M. T.	Hor. Intensity: Value	Instruments: Mag'r	Instruments: Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Incante	5 34.1 S	298 51	Oct 6,'14	8.5, 9.6	0 18.8 E	11.1	16 15.2 N	8.8, 9.4	.29210	19	19.56	HRS
Nova Olinda	5 34.5 S	295 40	Dec 10, 17	12.8,14.5	1 48.4 E	9.4	16 03.0 N	13.3,14.1	.29593	21	21.12(3(6)	AS
Natal	5 46.7 S	324 49	Jun 28, 19	13.2,14.5	17 41.6 W	12.5,12.7	6 28.5 N	13.6,14.2	.28196	28	EI 28	DMW
Boca de Capana	5 51.6 S	298 14	Oct 4, 14	10.2,11.4	0 26.0 E	14.0	15 48.2 N	10.5,11.1	.29100	19	19.56	HRS
Grande Rapids	6 08.2 S	311 35	Jul 26, 15	16.5	8 40.1 W	17.2	14 32.5 N	....	....	19	19.(12)	DWB
			Jul 27, 15	7.2	8 30.4 W	....	....	7.6, 8.2	.28338	19	....	DWB
Bom Futuro	6 15.1 S	297 40	Oct 1, 14	10.5,11.6	1 07.0 E	15.2	14 26.1 N	10.8,11.4	.29256	19	19.56	HRS
			Oct 2, 14	6.3 to 17.8 (dv)	1 08.5 E	....	....	....	....	19	....	HRS
São Miguel Rapids	6 20.2 S	311 28	Jul 23, 15	17.0	8 32.5 W	....	....	....	....	19	....	DWB
			Jul 24, 15	6.7	8 31.0 W	8.9	14 21.4 N	7.1, 7.6	.28308	19	19.(12)	DWB
Iguatu	6 22.0 S	320 43	Apr 25, 19	15.2,17.0	15 22.6 W	....	....	15.8,16.8	.28183	28	....	DMW
			Apr 26, 19	....	....	6.8, 7.1	8 53.0 N	....	....	....	EI 28	DMW
Villa Nova	6 33.3 S	301 43	Mar 12, 18	10.3,14.2	1 51.2 W	15.5	15 28.7 N	10.8,13.8	.28729	21	21.12(3(6)	AS
Allianca	6 33.5 S	295 36	Dec 12, 17	12.8,14.7	2 01.8 E	....	....	13.3,14.3	.29378	21	....	AS
			Dec 13, 17	....	....	9.9	14 26.4 N	....	....	....	21.12	AS
Praia Flor do Calcho	6 48.3 S	310 55	Jul 21, 15	6.1, 8.4	8 06.1 W	9.1	13 45.9 N	7.5, 8.1	.28272	19	19.(12)	DWB
Cabedello	6 58.5 S	325 10	Jun 29, 19	13.1,14.4	17 48.0 W	12.0,12.2	4 06.7 N	13.4,14.1	.28048	28	EI 28	DMW
Labrea	7 15.4 S	295 10	Dec 19, 17	13.8,15.8	2 26.4 E	....	....	14.3,15.4	.29276	21	....	AS
			Dec 20, 17	7.6 to 17.5 (dv)	2 28.7 E	....	....	....	....	21	....	AS
			Dec 21, 17	....	....	9.7	13 18.1 N	....	....	....	21.2(3(6)	AS
Barra do São Manoel	7 20.5 S	301 56	Mar 9, 18	9.8,11.8	1 58.8 W	17.6	13 56.8 N	10.3,11.3	.28765	21	21.12	AS
Praia do Cigano	7 27.5 S	310 38	Jul 18, 15	8.0, 9.7	7 35.2 W	9.1	12 40.0 N	7.0, 7.7	.28159	19	19.(12)	DWB
Humayta	7 30.3 S	296 51	Sep 28, 14	8.2, 9.4	1 51.6 E	11.2	12 19.8 N	8.5, 9.1	.29033	19	19.56	HRS
Hyutanahan	7 39.6 S	294 13	Dec 24, 17	9.7,13.4	3 16.0 E	14.7	11 59.6 N	10.1,10.9	.29366	21	21.12(3(6)	AS
Jacusao Rapids	7 43.5 S	310 42	Jul 14, 15	17.4	6 50.7 W	....	....	....	....	19	....	DWB
			Jul 15, 15	8.4	6 44.2 W	9.4	12 24.8 N	7.4, 8.0	.27972	19	19.(12)	DWB
Bocca do Pauhiny	7 47.2 S	292 55	Dec 30, 17	8.8,10.8	3 44.5 E	14.7	11 08.4 N	9.4,10.4	.29578	21	21.12(3(6)	AS
Pernambuco	8 03.7 S	325 07	Jul 3, 19	13.4,15.2	17 36.4 W	16.2,16.4	2 00.4 N	13.9,14.8	.27826	28	EI 28	DMW
Pombal	8 13.1 S	296 37	Sep 26, 14	9.0,10.2	2 04.5 E	11.9	10 56.0 N	9.3,10.0	.29436	19	19.56	HRS
Conceição	8 15.5 S	310 43	Jul 8, 15	14.9	7 50.1 W	....	....	15.5,16.2	.28072	19	....	DWB
			Jul 9, 15	9.6	7 51.2 W	11.0	11 15.8 N	....	....	19	19.(1)	DWB
			Jul 9, 15	12.7 to 16.4 (dv)	7 53.0 W	....	....	....	....	19	....	DWB
			Jul 10, 15	7.8, 9.1,11.6	7 50.2 W	8.5	11 19.9 N	....	....	19	19.(12)	DWB
			Jul 10, 15	9.2 to 11.2 (dv)	7 51.1 W	....	....	....	....	19	....	DWB
Bocca do Acre	8 45.5 S	292 36	Jan 20, 18	14.2,16.0	4 09.0 E	16.3	9 21.5 N	14.6	.29326	21	21.1	AS
Porto Velho	8 45.6 S	296 05	Sep 19, 14	8.6, 9.7	2 27.3 E	12.0	10 39.7 N	8.9, 9.4	.28998	19	19.56	HRS
			Oct 21, 17	7.1 to 16.2 (dv)	1 57.1 E	....	....	....	....	21	....	AS
			Oct 22, 17	9.8,11.3	1 59.5 E	15.3	10 57.2 N	10.2,11.0	.29122	21	21.12(3(6)	AS
Santa Maria Nova	8 48.3 S	310 25	Jul 6, 15	8.1, 9.6	7 51.6 W	10.3	10 23.4 N	8.6, 9.3	.27966	19	19.(12)	DWB
Barreira Quicaca	9 26.6 S	309 54	Jul 4, 15	7.6, 9.0	7 01.0 W	9.6	9 30.2 N	8.0, 8.6	.27757	19	19.(12)	DWB
Abuna	9 42 S	294 37	Oct 15, 17	9.4,11.6	3 10.0 E	14.0	8 32.6 N	9.9,11.2	.29190	21	21.12	AS
Empreza	9 58.5 S	292 12	Jan 15, 18	12.9,15.6	5 01.8 E	....	....	13.4,14.6	.29300	21	....	AS
			Jan 16, 18	8.0 to 17.4 (dv)	5 02.8 E	....	....	....	....	21	....	AS
			Jan 17, 18	....	....	11.5	7 20.6 N	....	....	....	21.12(3(6)	AS
Praia Joachim Alvez	10 06.0 S	309 37	Jul 2, 15	7.6, 9.0	6 33.4 W	9.6	8 34.8 N	8.1, 8.7	.27635	19	19.(12)	DWB
Xapury	10 38.9 S	291 27	Jan 9, 18	14.8,16.7	4 52.2 E	....	....	15.2,16.2	.29302	21	....	AS
			Jan 10, 18	....	....	9.8	6 12.2 N	....	....	....	21.12(3(6)	AS
Tapirape River	10 39.6 S	309 24	Jun 30, 15	7.6, 9.0	6 34.4 W	9.6	7 05.9 N	8.0, 8.7	.27572	19	19.(12)	DWB
Fontura's Village	11 23.9 S	309 18	Jun 28, 15	7.2, 8.6	6 27.2 W	9.2	6 18.8 N	7.6, 8.3	.27362	19	19.(12)	DWB
Rio das Mortes	11 45.8 S	309 18	Jun 26, 15	17.2	6 11.0 W	....	....	....	....	19	....	DWB
Araguaya River, 11	11 56.6 S	309 22	Jun 25, 15	17.3	6 04.5 W	....	....	....	....	19	....	DWB
			Jun 26, 15	7.4	6 01.6 W	9.2	5 17.0 N	7.9, 8.5	.27531	19	19.(12)	DWB
Guaporé 10	12 13.3 S	295 26	Sep 6, 14	9.3,10.5	3 42.8 E	12.4	3 27.8 N	9.6,10.2	.28495	19	19.56	HRS
Guaporé 9	12 23.9 S	295 31	Sep 5, 14	12.7,13.7	3 22.1 E	15.6	2 44.1 N	13.0,13.4	.28235	19	19.56	HRS
Guaporé 8	12 30.6 S	296 25	Aug 31, 14	12.6,13.6	3 14.6 E	15.4	3 18.2 N	12.9,13.3	.28212	19	19.56	HRS
			Sep 1, 14	7.1 to 17.5 (dv)	3 14.0 E	....	....	....	....	19	....	HRS
Lago Barreira do Viado	12 30.6 S	309 22	Jun 23, 15	17.4	6 12.1 W	....	....	....	....	19	....	DWB
			Jun 24, 15	8.0	6 10.3 W	9.6	3 58.4 N	8.4, 9.0	.27150	19	19.(12)	DWB
Bocca do Foro Island	12 54.3 S	309 30	Jun 22, 15	7.3, 9.3	6 23.2 W	9.8	3 32.2 N	7.8, 8.4	.26976	19	19.(12)	DWB
Guaporé 6	13 21.8 S	298 00	Aug 22, 14	9.5,10.5	2 23.2 E	12.0	2 27.3 N	9.8,10.3	.27930	19	19.256	HRS
Café Island	13 28.8 S	309 19	Jun 19, 15	17.1	6 14.0 W	....	....	....	....	19	....	DWB
			Jun 20, 15	8.1	6 11.1 W	10.1	2 43.5 N	8.7, 9.3	.27112	19	19.(12)	DWB
Guaporé 4	13 29.7 S	298 56	Aug 11, 14	10.7,11.7	1 47.7 E	14.9	2 40.8 N	11.0,11.5	.27852	19	19.256	HRS
Melancia Island	14 01.7 S	309 09	Jun 18, 15	7.5, 8.9	6 04.0 W	9.8	1 56.7 N	7.9, 8.6	.26845	19	19.(12)	DWB
Guaporé 2	14 01.8 S	299 37	Aug 5, 14	10.8,11.8	1 49.5 E	14.8	1 48.2 N	11.1,11.6	.27812	19	19.256	HRS
Guaporé 1	14 32.6 S	299 52	Aug 1, 14	9.6 to 17.5 (dv)	1 34.8 E	....	....	....	....	19	....	HRS
			Aug 2, 14	....	....	13.7	0 50.5 N	10.9,11.4	.27572	19	19.256	HRS
Canga Island	14 36.3 S	309 03	Jun 16, 15	7.4, 9.2	5 33.3 W	9.8	0 44.7 N	8.0, 8.8	.26747	19	19.(12)	DWB
Leopoldina	14 55.0 S	308 56	May 27, 15	8.4, 9.6	5 43.4 W	11.2	0 16.4 N	8.7, 9.3	.26747	19	19.(1)	DWB
			May 28, 15	8.1, ...	5 44.0 W	9.2	0 14.2 N	....	....	19	19.(12)	DWB
			May 28, 15	10.7 to 15.8 (dv)	5 44.2 W	....	....	....	....	19	....	DWB
Matto Grosso	15 00.6 S	300 00	Jul 29, 14	10.4,11.7	1 45.7 E	14.2	0 00.4 N	10.9,11.5	.26923	19	19.256	HRS

SOUTH AMERICA.

BRAZIL—*Concluded.*

Station	Latitude	Long. East of Gr.	Date	Declination		Inclination		Hor. Intensity		Instruments		Obs'r
				Local Mean Time	Value	L. M. T.	Value	L. M. T.	Value	Mag'r	Dip Circle	
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Barreira Branca	15 02.0 S	308 43	Jun 1, '15	16.8	5 24.5 W	....	....	....	....	19	....	DWB
			Jun 2, 15	9.3	5 23.4 W	9.9	0 10.1 N	8.1, 8.8	.26674	19	19.(12)	DWB
Barreira Canta Gallo	15 05.3 S	308 28	Jun 3, 15	16.8	5 08.9 W	....	....	....	....	19	....	DWB
			Jun 4, 15	....	....	9.4	0 07.8 N	7.5, 8.1	.26714	19	19.(12)	DWB
			Jun 11, 15	17.2	5 11.6 W	....	....	....	....	19	....	DWB
			Jun 12, 15	7.1	5 08.5 W	....	....	....	....	19	....	DWB
Pontes e Lacerdas	15 13.3 S	300 36	Jul 26, 14	10.8,11.8	1 07.1 E	15.9	0 00.8 N	11.1,11.6	.27310	19	19.256	HRS
Barreira do Padre	15 21.7 S	308 22	Jun 6, 15	9.0	5 11.7 W	9.7	0 26.0 S	7.9, 8.6	.26846	19	19.(12)	DWB
			Jun 11, 15	7.0	5 09.4 W	....	....	....	....	19	....	DWB
Rio Terreiro	15 35.8 S	309 25	May 21, 15	8.6,10.1	5 55.2 W	11.4	1 03.2 S	8.9, 9.6	.26554	19	19.(12)	DWB
Asareas	15 37.5 S	301 38	Jul 23, 14	10.5,11.7	0 47.4 E	15.0	0 33.1 S	10.9,11.5	.27173	19	19.256	HRS
Registro	15 44.8 S	308 13	Jun 9, 15	7.5, 9.2	5 44.1 W	11.3	1 44.2 S	8.1, 8.8	.26164	19	19.(1)	DWB
Goyaz	15 56.6 S	309 52	May 13, 15	8.1, 9.6	6 11.6 W	10.8	1 41.7 S	8.6, 9.2	.26518	19	19.(12)	DWB
			May 14, 15	8.4 to 15.7 (dv)	6 11.8 W	....	....	....	....	19	....	DWB
Fumasa	15 58.0 S	301 39	Jul 20, 14	10.6,11.8	0 30.4 E	14.8	1 08.3 S	10.9,11.5	.27180	19	19.256	HRS
Curralinho	16 02.0 S	310 12	May 3, 15	8.6,10.6	6 36.3 W	11.4	1 53.6 S	9.1, 9.7	.26452	19	19.(12)	DWB
São Luiz de Caceres	16 04.1 S	302 17	Jul 9, 14	10.1,11.4	0 02.0 W	14.2	1 11.9 S	10.6,11.1	.27024	19	19.256	HRS
			Jul 14, 14	8.1 to 16.5 (dv)	0 01.6 W	....	....	....	....	19	....	HRS
Porto Curichao	16 37.0 S	302 07	Jul 8, 14	9.9,10.8	0 08.3 E	13.9	2 11.3 S	10.2,10.6	.26928	19	19.256	HRS
Campinas	16 40.8 S	310 43	Apr 29, 15	8.0, 9.6	6 38.0 W	10.8	3 14.7 S	8.7, 9.3	.26272	19	19.(12)	DWB
Bella Vista	16 59.4 S	311 05	Apr 26, 15	8.6,10.5	7 00.5 W	11.1	3 38.0 S	9.0, 9.6	.26053	19	19.(12)	DWB
Porto Concepcion	17 08.8 S	302 37	Jul 7, 14	9.6,10.9	0 09.4 W	13.6	3 01.6 S	10.0,10.6	.26758	19	19.256	HRS
Santa Cruz	17 19.5 S	311 34	Apr 23, 15	8.7,10.0	7 15.4 W	11.0	4 25.0 S	9.1, 9.7	.26000	19	19.(12)	DWB
Lake Gaiba	17 44.3 S	302 20	Jul 6, 14	10.4,11.6	0 08.8 E	14.6	4 06.3 S	10.7,11.3	.26566	19	19.256	HRS
Fazenda Cachoeira	17 45.7 S	311 54	Apr 20, 15	8.2, 9.8	7 45.2 W	10.5	5 33.7 S	8.6, 9.2	.25721	19	19.(12)	DWB
Catalão	18 10.8 S	312 07	Apr 17, 15	9.0,10.4	8 10.1 W	12.0	5 55.5 S	9.4,10.0	.25658	19	19.(12)	DWB
Porto Baguary	18 25.5 S	302 36	Jul 5, 14	10.4,11.6	0 04.0 E	14.5	5 12.6 S	10.8,11.4	.26466	19	19.256	HRS
Araguary	18 39.0 S	311 49	Apr 15, 15	9.0,10.5	7 28.2 W	12.3	6 33.6 S	9.4,10.1	.25726	19	19.(12)	DWB
Corumba	18 59.4 S	302 21	Jun 26, 14	10.1,11.6	0 26.2 E	13.6	6 12.2 S	10.5,11.3	.26328	19	19.256	HRS
			Jun 26, 14	....	....	16.0	6 15.1 S	....	....	.....	19.256	HRS
Vassouras, *A*	22 24.0 S	316 21	Mar 29, 15	13.9,17.0	10 25.4 W	....	....	14.6,16.2	.24580	19	....	DWB
			Mar 30, 15	8.7,11.1	10 29.5 W	....	....	9.3,10.4	.24600	19	....	DWB
			Mar 30, 15	14.0,16.4	10 26.6 W	....	....	14.6,15.8	.24567	19	....	DWB
			Mar 31, 15	....	....	9.1	14 40.4 S	....	....	.....	19.(12)	DWB
			Mar 31, 15	....	....	11.3	14 39.0 S	....	....	.....	19.(12)	DWB
			Mar 31, 15	....	....	15.1	14 43.4 S	....	....	.....	19.(12)	DWB
			Sep 23, 19	16.6	11 13.4 W	....	....	....	....	16	....	AS
			Sep 24, 19	9.5 to 17.1 (6)	11 10.7 W	....	....	10.1 to 16.7 (6)	.24450	16	....	AS
			Sep 26, 19	....	....	10.7	15 12.1 S	....	....	.....	242.1256	AS
			Sep 26, 19	....	....	14.1	15 16.7 S	....	....	.....	242.1256	AS
			Sep 26, 19	....	....	15.8	15 18.8 S	....	....	.....	242.1256	AS
Vassouras, *B*	22 24.0 S	316 21	Mar 26, 15	14.6,15.7,16.7	10 26.5 W	....	....	....	....	19	....	DWB
			Mar 27, 15	....	....	....	....	10.8	.24614	19	....	DWB
			Mar 27, 15	....	....	....	....	14.9,16.7	.24581	19	....	DWB
			Mar 28, 15	10.6,16.9,17.2	10 28.0 W	....	....	8.4	.24577	19	....	DWB
			Mar 28, 15	....	....	....	....	14.3,15.9	.24596	19	....	DWB
			Mar 29, 15	8.0,10.9	10 27.0 W	....	....	8.9,10.3	.24610	19	....	DWB
			Mar 31, 15	....	....	16.7	14 42.2 S	....	....	.....	19.(12)	DWB
			Apr 1, 15	....	....	8.4	14 40.7 S	....	....	.....	19.(12)	DWB
			Apr 1, 15	....	....	9.8	14 38.0 S	....	....	.....	19.(12)	DWB
			Sep 23, 19	16.2	11 12.2 W	....	....	....	....	16	....	AS
			Sep 25, 19	8.6 to 17.1 (6)	11 08.7 W	....	....	9.0 to 16.7 (6)	.24452	16	....	AS
Vassouras, *C*	22 24.0 S	316 21	Sep 27, 19	....	....	9.7,11.3	15 09.1 S	....	....	.....	242.1256	AS
			Sep 27, 19	....	....	13.6	15 15.0 S	....	....	.....	242.1256	AS
Vassouras, *E*	22 24.0 S	316 21	Sep 23, 19	14.2	11 04.7 W	....	....	....	....	16	....	AS
Vassouras, *F*	22 24.0 S	316 21	Sep 23, 19	15.2	11 08.7 W	....	....	....	....	16	....	AS
Vassouras, *G*	22 24.0 S	316 21	Sep 23, 19	14.7	11 06.7 W	....	....	....	....	16	....	AS
Rio de Janeiro, *B*	22 58.7 S	316 49	Apr 3, 15	11.1,12.7	10 35.6 W	14.0	15 20.6 S	11.6,12.3	.24629	19	19.(12)	DWB

CHILE.

Station	Latitude	Long. East of Gr.	Date	Decl. LMT	Decl. Value	Incl. L. M. T.	Incl. Value	H. I. L. M. T.	H. I. Value	Mag'r	Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Puquios	18 11.0 S	290 20	Apr 7, '14	9.4,10.6	8 09.5 E	12.5	9 03.0 S	9.7,10.4	.27961	19	19.256	HRS
Estacion Central	18 22.6 S	290 03	Apr 5, 14	9.5,10.6	7 59.5 E	12.3	9 07.6 S	9.8,10.4	.27898	19	19.256	HRS
Arica	18 28.6 S	289 40	Apr 3, 14	9.3,10.6	7 52.4 E	12.0	9 10.5 S	9.7,10.3	.27997	19	19.256	HRS
			Feb 7, 17	8.6,10.6	7 36.0 E	14.2	8 46.1 S	9.1,10.2	.28069	21	21.(3(56)	AS
Nivel	19 35 S	289 54	Feb 13, 17	....	....	10.9	11 04.6 S	....	....	.....	21.(3(6)	AS
Pisagua	19 35.0 S	289 49	Feb 14, 17	13.9,15.9	8 04.6 E	10.9	10 56.2 S	14.4,15.4	.27386	21	21.(3(6)	AS
			Feb 15, 17	8.3 to 17.9(dv)	8 08.3 E	....	....	....	....	21	....	AS

SOUTH AMERICA.

CHILE—*Concluded.*

Station	Latitude	Long. East of Gr.	Date	Declination		Inclination		Hor. Intensity		Instruments		Obs'r
				Local Mean Time	Value	L. M. T.	Value	L. M. T.	Value	Mag'r	Dip Circle	
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Iquique	20 12.7 S	289 50	Feb 10, '17	10.7,13.9	8 45.6 E	15.3	11 24.8 S	11.2,13.5	.27452	21	21.(3(6)	AS
Pintados	20 37.7 S	290 24	Feb 21, 17	8.3,10.2	8 23.6 E	12.4	12 53.0 S	8.8, 9.8	.27322	21	21.(3(6)	AS
Toco	22 04.5 S	290 24	Feb 27, 17	13.7,15.5	9 05.0 E	16.7	14 35.4 S	14.1,15.0	.27025	21	21.(3(6)	AS
Tocopilla	22 05.2 S	289 48	Feb 25, 17	10.2,13.1	8 57.3 E	14.5	14 39.5 S	10.7,11.6	.27461	21	21.(3(6)	AS
Antofagasta	23 38.8 S	289 38	Mar 3, 17	13.1,15.1	9 28.0 E	16.1	17 24.4 S	13.6,14.7	.26959	21	21.(3(6)	AS
			May 16, 17	8.2 to 17.4 (dv)	9 25.9 E	....	....	....	....	21	....	AS
			May 17, 17	12.6,14.4	9 26.9 E	10.7	17 24.2 S	13.1,14.0	.26910	21	21.(3(56)	AS
Catalina	25 14.6 S	290 20	Mar 11, 17	9.6,11.4	10 12.2 E	....	....	10.0,11.0	.26883	21	....	AS
			Mar 12, 17	....	....	9.5	18 38.7 S	....	....	......	21.(3(6)	AS
Taltal	25 23.6 S	289 35	Mar 14, 17	12.8,14.5	9 48.3 E	16.0	20 00.3 S	13.2,14.1	.26906	21	21.(3(6)	AS
			Mar 15, 17	7.5 to 17.8 (dv)	9 41.2 E	....	....	....	....	21	....	AS
Chanaral	26 20.4 S	289 27	Mar 17, 17	12.8,14.8	10 48.1 E	16.1	21 18.4 S	13.3,14.3	.26752	21	21.(13(56)	AS
Caldera	27 04.0 S	289 14	Mar 23, 17	9.4,11.2	11 10.2 E	14.2	22 18.4 S	9.8,10.7	.26672	21	21.(3(6)	AS
Copiapo	27 22.0 S	289 43	Mar 25, 17	9.2,11.0	10 21.3 E	13.7	22 49.1 S	9.6,10.6	.26568	21	21.(1(6)	AS
Huasco	28 27.2 S	288 51	Mar 30, 17	....	....	15.4	24 26.4 S	....	....	......	21.(13(6)	AS
			Mar 31, 17	8.2 to 17.7 (dv)	11 26.7 E	....	....	....	....	21	....	AS
			Apr 1, 17	8.4,10.2	11 21.8 E	....	....	8.8, 9.8	.26448	21	....	AS
Vallenar	28 34.9 S	289 18	Mar 27, 17	9.8,11.6	11 13.5 E	14.9	24 02.2 S	10.3,11.2	.26508	21	21.(13)	AS
Coquimbo	29 57.8 S	288 40	Apr 6, 17	10.0,11.8	11 27.1 E	13.9	26 14.9 S	10.5,11.4	.26512	21	21.(3(6)	AS
Valparaiso	33 04.4 S	288 25	Apr 14, 17	9.9,13.2	13 33.3 E	14.5	30 28.1 S	10.9,12.0	.26176	21	21.(3(6)	AS
Santiago, *A*	33 26.7 S	289 18	Apr 18, 17	10.1,11.8	13 24.4 E	14.2	30 18.8 S	10.6,11.4	.26308	21	21.(13(6)	AS
			May 5, 17	11.1,12.5	13 26.4 E	13.2	30 18.4 S	11.5	.26265	21	21.(3(6)	AS
			Mar 24, 19	10.2,12.4	13 15.2 E	13.9	30 08.1 S	10.8,12.0	.26175	16	242.1256	AS
Concepcion	36 49.6 S	286 57	Jan 16, 18	10.6,14.5	15 19.6 E	15.3,15.5	34 52.7 S	11.6,14.1	.26452	25	EI 25	C V
Coronel, *A*	37 01.9 S	286 51	Apr 25, 17	13.1,15.0	15 29.7 E	16.3	35 22.5 S	13.6,14.5	.26492	21	21.(13(56)	AS
			Apr 29, 17	8.1 to 17.0 (dv)	15 26.4 E	....	....	....	....	21	....	AS
Coronel, *C*	37 01.9 S	286 51	Apr 30, 17	10.0,12.8	15 25.1 E	13.9	35 22.0 S	10.4,11.2	.26439	21	21.(13(56)	AS
Coronel, *D*	37 01.9 S	286 51	Jan 19, 18	10.6,12.9,13.8	15 27.5 E	14.7,14.9	35 11.6 S	11.0,12.4	.26484	25	EI 25	C V
Puerto Montt	41 29.3 S	287 04	Mar 28, 19	13.0,15.0	16 10.2 E	....	....	13.5,14.6	.26577	16	....	AS
			Mar 29, 19	....	....	11.2	40 11.4 S	....	....	......	242.1256	AS
Ultima Esperanza	51 41.1 S	287 31	Apr 10, 19	10.4,11.5	19 00.2 E	13.6	48 41.0 S	10.8	.27050	16	242.56	AS
Punta Arenas	53 10.4 S	289 08	Apr 8, 19	10.2	18 33.5 E	....	....	10.7,11.6	.26941	16	....	AS
			Apr 14, 19	....	....	14.2	49 51.5 S	....	....	......	242.256	AS
			Apr 16, 19	8.5 to 16.0 (dv)	18 34.8 E	....	....	....	....	16	....	AS
			Apr 17, 19	15.3	18 35.1 E	....	....	....	....	16	....	AS

COLOMBIA.

Station	Latitude	Long. East of Gr.	Date	Declination L. M. T.	Declination Value	Inclination L. M. T.	Inclination Value	Hor. Intensity L. M. T.	Hor. Intensity Value	Mag'r	Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Mata de Guanabano	6 12.2 N	291 47	Apr 28, '14	12.7,14.5	1 28.6 E	16.7	33 28.0 N	13.3,14.2	.30966	21	21.(343)4)	ADP
			Apr 29, 14	7.7 to 18.1 (dv)	1 29.2 E	....	....	....	....	21	....	ADP
Meta River 1	6 10.8 N	291 13	May 4, 14	9.9,12.3	1 36.2 E	14.2	33 38.4 N	10.6,11.4	.30976	21	21.(343)4)	ADP
Meta River 2	6 02.5 N	290 29	May 9, 14	8.4,10.6	1 59.2 E	12.3	32 52.7 N	9.5,10.3	.31190	21	21.(343)4)	ADP
Meta River 3	5 36.6 N	289 54	May 13, 14	9.8,11.4	2 13.4 E	13.1	32 14.4 N	10.4,11.1	.31233	21	21.(343)4)	ADP
Meta River 4	5 21.9 N	289 26	May 17, 14	8.7,12.8	2 31.2 E	15.2	31 44.0 N	11.2,12.2	.31268	21	21.(343)4)	ADP
Orocue	4 47.8 N	288 46	May 23, 14	11.2,16.2	2 57.1 E	17.2	30 34.7 N	14.0,14.9	.31307	21	21.(343)4)	ADP
			May 23, 14	....	....	....	....	16.0	.31289	21	....	ADP
Bogota	4 37.6 N	285 54	Jun 26, 14	12.8,14.6	3 46.2 E	15.7	29 26.1 N	13.3,14.2	.31710	21	21.(343)4)	ADP
Culate de Pupures	4 28.0 N	288 12	May 29, 14	15.8,17.5	3 08.1 E	....	....	16.4,17.1	.31460	21	....	ADP
			May 30, 14	....	....	8.3	29 54.4 N	....	....	......	21.(343)4)	ADP
Remolino de San Migel	4 17.2 N	287 29	Jun 4, 14	8.5,11.3	3 26.0 E	13.8	29 33.4 N	10.2,10.9	.31512	21	21.(343)4)	ADP
Barrigon	4 10.4 N	287 04	Jun 8, 14	9.5,11.3	3 42.4 E	13.8	29 21.6 N	10.1,10.9	.31413	21	21.(343)4)	ADP
Villa Vicencia	4 08.9 N	286 29	Jun 13, 14	11.4,15.0	3 58.4 E	16.4	28 55.5 N	13.8,14.6	.31534	21	21.(343)	ADP
Neiva	2 55.5 N	284 35	Jul 8, 14	10.9,12.7	4 40.6 E	14.8	26 32.1 N	11.6,12.4	.31765	21	21.(34)4)	ADP
Guadalupe	2 01.3 N	283 59	Jul 14, 14	10.4,12.4	5 13.3 E	15.0	24 47.0 N	11.0,11.7	.31722	21	21.(343)4)	ADP
Tumaco	1 48.3 N	281 14	Oct 21, 16	....	....	17.5	24 20.9 N	....	....	......	21.(56)	W&S
			Oct 22, 16	6.7, 9.0	6 09.8 E	....	....	7.1, 8.7	.31930	21	....	W&S
Florencia	1 36.3 N	284 04	Jul 18, 14	10.1,11.9	5 01.2 E	14.2	24 18.2 N	10.9,11.6	.31728	21	21.(34)4)	ADP
Bella Vista	1 09.5 N	284 11	Jul 22, 14	8.9,10.5	4 54.8 E	12.6	23 14.0 N	9.4,10.1	.31801	21	21.(343)4)	ADP
La Victoria	0 44.6 N	284 27	Jul 24, 14	8.6,10.9	5 07.6 E	13.4	22 35.9 N	9.7,10.5	.31772	21	21.(33)4)	ADP
El Baradero del Micaya	0 22.6 N	284 06	Aug 2, 14	Various	5 14.5 E	....	....	....	....	21	....	ADP
			Aug 3, 14	10.3	5 14.5 E	....	....	....	....	21	....	ADP
			Aug 4, 14	8.8, 10.6....	5 15.5 E	12.5	21 34.1 N	9.4,10.3	.31626	21	21.(343)4)	ADP
La Reforma	0 03.7 S	284 15	Aug 17, 14	10.7,15.6	5 17.8 E	17.4	21 36.9 N	14.5,15.2	.31639	21	21.(343)4)	ADP

SOUTH AMERICA.

ECUADOR.

Station	Latitude	Long. East of Gr.	Date	Declination: Local Mean Time	Declination: Value	Inclination: L. M. T.	Inclination: Value	Hor. Intensity: L. M. T.	Hor. Intensity: Value	Instruments: Mag'r	Instruments: Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Quito	0 13.1 S	281 20	Oct 29, '16	9.8,11.2	6 22.6 E	13.1	20 38.7 N	10.2,10.9	.32188	21	21.(3)	W&S
Riobamba*	1 39.5 S	281 18	Oct 31, 16	8.6,11.2	6 36.8 E	14.1	12 04.6 N	9.4,10.6	.33632	21	21.(3(6)	W&S
Guayaquil	2 10.8 S	280 09	Nov 2, 16	11.5,15.8	6 57.9 E	....	....	12.6,15.2	.32028	10	....	W&S
			Nov 3, 16	....	....	9.7	16 31.0 N	....	....	......	21.(3(5)	W&S

GUIANA.

Station	Latitude	Long. East of Gr.	Date	Declination: Local Mean Time	Declination: Value	Inclination: L. M. T.	Inclination: Value	Hor. Intensity: L. M. T.	Hor. Intensity: Value	Instruments: Mag'r	Instruments: Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Georgetown	6 48.6 N	301 51	Jun 2, '18	10.9,14.2	4 34.5 W	15.7	36 22.2 N	11.4,13.8	.29680	21	21.12(3(6)	AS
			Jun 22, 18	9.8,10.1	4 34.7 W	....	....	....	....	21	....	AS
New Amsterdam	6 16.3 N	302 29	Jun 20, 18	14.3,15.6	4 59.2 W	17.0	36 05.0 N	14.8	.29445	21	21.12	AS
Paramaribo, *A*	5 50.0 N	304 51	Jun 11, 18	10.4,11.6	6 02.2 W	15.8	35 23.8 N	10.8,14.3	.29344	21	21.12(3(6)	AS
			Jun 13, 18	7.2 to 17.7 (dv)	6 09.7 W	....	....	....	....	21	....	AS
			Jun 17, 18	8.6	6 06.0 W	....	....	....	....	21	....	AS
Paramaribo, *B*	5 50.0 N	304 52	Jun 17, 18	9.5, 9.8	6 05.6 W	....	....	....	....	21	....	AS
Cayenne	4 56.1 N	307 40	May 21, 18	17.0	8 20.8 W	....	....	....	....	21	....	AS
			May 22, 18	15.6	8 23.2 W	....	....	12.7,14.4	.29328	21	....	AS
			May 23, 18	13.5,15.7	8 19.5 W	14.6	34 13.0 N	....	....	21	21.12(3(6)	AS
			May 26, 18	8.3 to 17.5 (dv)	8 18.8 W	....	....	....	....	21	....	AS

PERU.

Station	Latitude	Long. East of Gr.	Date	Declination: Local Mean Time	Declination: Value	Inclination: L. M. T.	Inclination: Value	Hor. Intensity: L. M. T.	Hor. Intensity: Value	Instruments: Mag'r	Instruments: Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
El Jubineto	1 00.2 S	285 30	Aug 22, '14	16.8,18.3	5 03.8 E	....	....	17.3,18.0	.31267	21	....	ADP
			Aug 23, 14	....	....	9.6	19 59.8 N	....	....	......	21.(343)4)	ADP
El Encanto	1 37.7 S	286 29	Aug 28, 14	10.5,12.0	5 04.2 E	15.0	19 13.2 N	11.0,11.7	.31155	21	21.(343)4)	ADP
Putumayo 1	2 11.4 S	287 52	Sep 1, 14	15.3	4 38.4 E	....	....	16.3,17.6	.30027	21	....	ADP
			Sep 2, 14	7.4, 8.8	4 40.2 E	8.2	18 49.2 N	....	....	21	21.(34)	ADP
Putumayo 2	2 17.3 S	288 54	Sep 5, 14	10.2,11.7	4 17.8 E	13.6	18 57.9 N	10.7,11.4	.30744	21	21.(343)4)	ADP
Boca del Tupache	2 21.2 S	287 04	Aug 31, 14	13.7,15.5	4 54.0 E	16.9	18 12.1 N	14.3,15.1	.30936	21	21.(343)4)	ADP
Putumayo 3	2 39.0 S	289 36	Sep 8, 14	9.3,11.3	4 20.6 E	14.8	18 45.3 N	9.9,10.9	.30648	21	21.(343)4)	ADP
Hacienda Putante	8 24.2 S	283 53	Jun 21, 17	10.2,12.6	7 40.2 E	16.7,17.0	6 01.2 N	10.8,12.0	.30654	28	EI 28	W&J
			Jun 22, 17	8.0 to 17.6 (dv)	7 38.3 E	....	....	....	....	28	....	W&J
Huacrachuco	8 36.2 S	283 07	Jul 11, 17	8.7,10.6	7 55.8 E	11.5,11.8	5 26.5 N	9.2,10.1	.30706	28	EI 28	W&J
Andomayo	8 38.6 S	282 22	Jul 19, 17	16.7,16.9	8 00.8 E	....	....	17.5	.30639	28	....	W&J
			Jul 20, 17	....	....	6.8	5 05.3 N	....	....	......	EI 28	W&J
Shiraca	8 39.0 S	283 37	Jul 5, 17	....	....	16.9,17.1	5 41.8 N	....	....	......	EI 28	W&J
			Jul 6, 17	7.0, 9.1	7 48.4 E	....	....	7.6, 8.6	.30645	28	....	W&J
La Limeña	8 40.5 S	281 56	Jul 22, 17	14.9,16.0	8 06.6 E	14.5	4 44.0 N	15.3	.30635	28	EI 28	W&J
Chimbote	9 04.1 S	281 25	Jul 24, 17	11.4,13.6	8 06.8 E	14.5,14.8	4 21.2 N	11.9,13.2	.30580	28	EI 28	W&J
Tingo Maria	9 17.1 S	284 07	Jun 13, 17	14.7,16.8	7 40.1 E	....	....	15.3,16.4	.30400	28	....	W&J
			Jun 14, 17	....	....	14.1,15.3	4 33.8 N	....	....	......	EI 28	W&J
Hacienda San Juan	9 31.2 S	284 08	Jun 7, 17	13.6,15.8	7 44.8 E	11.3,11.5	4 09.6 N	14.1,15.4	.30260	28	EI 28	W&J
Huanuco, *A*	9 56.1 S	283 45	May 26, 17	12.8	7 54.0 E	....	....	14.4	.30272	28	....	W&J
			May 27, 17	10.0,10.5,13.5	7 54.0 E	....	....	9.4,11.1	.30260	28	....	W&J
			May 27, 17	....	....	....	....	13.0	.30276	28	....	W&J
			May 28, 17	8.7,11.2	7 54.2 E	....	....	9.5,10.7	.30232	28	....	W&J
			May 28, 17	12.3	7 54.2 E	....	....	....	....	10	....	W&J
			May 29, 17	12.2,13.1,15.3	7 55.2 E	....	....	10.4,11.7	.30260	10	....	W&J
			May 29, 17	....	....	....	....	13.5,14.8	.30218	10	....	W&J
			May 30, 17	10.4,12.6	7 54.2 E	7.5, 7.7	3 21.6 N	10.8,12.1	.30218	10	EI 28	W&J
			May 31, 17	7.6 to 17.0 (dv)	7 54.2 E	....	....	....	....	28	....	W&J
Huanuco, *B*	9 56.1 S	283 45	May 26, 17	12.8	7 53.2 E	....	....	14.4	.30194	10	....	W&J
			May 27, 17	10.0,10.5,13.5	7 53.4 E	....	....	9.3,11.1	.30221	10	....	W&J
			May 27, 17	....	....	....	....	13.0	.30223	10	....	W&J
			May 28, 17	8.7,11.2	7 52.9 E	....	....	9.5,10.7	.30215	10	....	W&J
			May 28, 17	12.3	7 53.9 E	....	....	....	....	28	....	W&J
			May 29, 17	12.2,13.1,15.3	7 54.2 E	....	....	10.4,11.6	.30288	28	....	W&J
			May 29, 17	....	....	....	....	13.5,14.7	.30252	28	....	W&J
			May 30, 17	10.4,12.6	7 53.8 E	....	....	10.8,12.1	.30254	28	....	W&J
Cerro de Pasco	10 41.3 S	283 45	May 21, 17	12.8,14.4	8 15.5 E	11.4	1 57.0 N	13.1,14.0	.30210	28	EI 28	DMW
Huacho	11 06.7 S	282 22	Dec 1, 16	7.1,10.6	8 32.4 E	13.6	0 24.0 N	7.9,10.1	.30288	21	21.(13(5)	W&S
			Dec 2, 16	6.1 to 17.9 (dv)	8 33.6 E	....	....	....	....	21	....	W&S
Sayan	11 08.4 S	282 48	Dec 9, 16	14.2,16.0	8 20.8 E	....	....	14.7,15.7	.30163	21	....	W&S
			Dec 10, 16	....	....	7.5	0 09.3 N	....	....	......	21.(13(6)	W&S

* Local disturbance.

SOUTH AMERICA.

PERU—*Continued.*

Station	Latitude	Long. East of Gr.	Date	Declination		Inclination		Hor. Intensity		Instruments		Obs
				Local Mean Time	Value	L. M. T.	Value	L. M. T.	Value	Mag'r	Dip Circle	
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Oroya	11 32.6 S	284 05	May 18, '17	10.5, 11.8	8 23.8 E	9.7, 9.8	0 22.4 N	10.9, 11.6	.30024	28	EI 28	W&J
Yangas, *A*	11 41.8 S	283 10	Dec 19, 16	13.8, 15.8	8 03.6 E			14.2, 15.3	.30132	21		W&S
			Dec 20, 16	6.8, 17.1 (dv)	8 04.2 E					21		W&S
			Dec 21, 16			14.7, 15.5	0 29.2 S				EI 5	W&S
Yangas, *B*	11 41.8 S	283 10	Dec 22, 16	15.8, 17.3	8 05.4 E	11.9	0 22.0 S	16.4	.30121	21	EI 5	W&S
Yangas, *C*	11 41.8 S	283 10	Dec 23, 16	11.9, 13.2	8 03.6 E	10.6	0 27.4 S	12.5	.30166	21	EI 5	W&S
Yangas, *D*	11 41.8 S	283 10	Dec 25, 16	15.4, 15.7	8 02.8 E	10.8	0 16.6 S	14.6	.30037	21	EI 5	W&S
Yangas, *E*	11 41.8 S	283 10	Dec 24, 16	11.2, 12.7	8 04.6 E	18.0	0 23.2 S	11.5	.30225	21	EI 5	W&S
Matucana	11 50.8 S	283 36	Nov 24, 16	14.2	8 32.0 E	16.6	0 54.1 S	14.8	.29973	21	21.(13)	W&S
			Nov 25, 16	8.2, 10.1	8 29.8 E	11.1	0 46.3 S	8.6, 9.6	.30138	21	21.(6)	W&S
Pamparca, *B*	12 02.1 S	284 40	Apr 15, 17	11.1, 12.2	8 16.6 E	9.6, 9.9	0 11.3 S	11.5	.29910	28	EI 28	F&W
Pamparca, *A*	12 02.2 S	284 40	Apr 14, 17	13.2, 14.4	8 23.5 E	16.1, 16.5	0 13.2 S	13.7	.29907	28	EI 28	F&W
Pamparca, *C*	12 02.2 S	284 40	Apr 15, 17	13.1, 14.1	8 21.6 E	15.1, 15.3	0 10.9 S	13.5	.29842	28	EI 28	F&W
Huancayo Observatory, *Eccentric*	12 02.7 S	284 40	Oct 10, 19	9.2, 13.9	8 23.6 E					10		E&R
			Oct 11, 19	8.8, 11.4	8 23.3 E			9.6, 10.9	.29922	10		E&R
			Oct 13, 19	9.0, 11.8	8 18.0 E			9.9, 11.3	.29874	10		E&R
			Oct 16, 19	9.2 to 16.6 (dv)	8 20.1 E					10		E&R
			Oct 18, 19			11.2, 11.7	0 14.2 S				EI 5	E&R
			Oct 20, 19	9.1, 12.4	8 19.5 E	13.7, 14.1	0 13.2 S	9.9, 11.5	.29896	10	EI 5	E&R
			Oct 21, 19			11.7, 12.1	0 14.4 S				EI 5	E&R
			Oct 27, 19	9.0, 12.7	8 21.4 E	15.2, 15.6	0 11.8 S	9.8, 11.5	.29846	10	EI 5	E&R
			Nov 1, 19	8.8 to 16.6 (dv)	8 21.1 E					10		E&R
			Nov 3, 19	9.0, 12.8	8 20.0 E	14.1, 14.5	0 15.2 S	9.8, 11.4	.29900	10	EI 5	E&R
			Nov 10, 19	9.3, 13.0	8 20.8 E	14.5	0 13.9 S	10.0, 11.5	.29942	10	EI 5	E&R
			Nov 12, 19			8.7, 9.1	0 15.8 S				EI 5	E&R
			Nov 15, 19	8.8 to 16.6 (dv)	8 19.1 E					10		E&R
			Nov 17, 19	10.9, 13.9	8 19.6 E	9.2, 9.5	0 14.0 S	11.5, 13.3	.29827	10	EI 5	E&R
Huancayo Observatory, *Frame*	12 02.7 S	284 40	Nov 28, 19	10.8, 13.9	8 19.6 E			11.4, 13.4	.29904	10		E&R
			Nov 29, 19			10.2, 10.6	0 16.5 S				EI 5	E&R
			Dec 1, 19	8.8 to 16.6 (dv)	8 19.2 E					10		E&R
			Dec 8, 19	9.9, 13.3	8 19.1 E	14.3, 14.7	0 16.0 S	10.8, 12.8	.29872	10	EI 5	E&R
			Jan 5, 20	9.3, 12.3	8 20.2 E	14.7, 15.2	0 15.5 S	10.1, 11.7	.29924	10	EI 5	E&R
			Jan 6, 20	8.7 to 16.6 (dv)	8 16.4 E					10		E&R
			Jan 13, 20	8.4, 11.2	8 19.0 E	11.8, 12.3	0 15.6 S	9.2, 10.5	.29854	10	EI 5	E&R
			Jan 15, 20	8.9 to 16.6 (dv)	8 18.2 E					10		E&R
			Jan 19, 20	9.3, 12.2	8 20.5 E	14.1, 14.5	0 14.8 S	10.1, 11.6	.29995	10	EI 5	E&R
			Jan 26, 20	8.8, 11.8	8 19.0 E	13.4, 13.7	0 16.3 S	9.6, 11.2	.29871	10	EI 5	E&R
			Jan 31, 20	9.3 to 16.5 (dv)	8 19.5 E					10		E&R
			Feb 2, 20	9.2, 12.0	8 17.7 E	13.6, 14.0	0 16.2 S	9.6, 11.4	.29908	10	EI 5	E&R
			Feb 9, 20	9.0, 11.7	8 18.6 E	12.8, 13.3	0 20.4 S	9.8, 11.2	.29902	10	EI 5	E&R
			Feb 14, 20	8.8 to 16.6 (dv)	8 17.9 E					10		E&R
			Feb 16, 20	8.6, 10.9	8 18.0 E	11.6, 12.5	0 19.9 S	9.1, 10.4	.29807	10	EI 5	E&R
			Feb 23, 20	8.5, 11.0	8 19.5 E	11.7, 12.1	0 19.4 S	9.0, 10.4	.29867	10	EI 5	E&R
Huayao	12 02.8 S	284 39	Apr 16, 17	8.2, 9.4	8 19.7 E	10.2, 10.5	0 13.4 S	8.6	.29771	28	EI 28	JAF
			Jun 12, 19	13.2, 14.9	8 15.0 E	8.8, 9.0	0 09.9 S	13.6, 14.5	.29746	10	EI 5	HME
Huayao, *Eclipse*	12 03.0 S	284 38	May 26 to Jun 12, 19	Mag'gram value mean of 17 days	8 13.3 E		0 05.5 S		.29818	10 & 2[1]	EI 5	HME
Lima, Hipodromo	12 04.3 S	282 58	Mar 25, 14	10.4, 12.2	8 46.8 E	14.0	1 34.6 S	10.9, 11.8	.30120	19	19.256	HRS
			Mar 29, 14	9.4 to 17.0 (dv)	8 48.8 E					19		HRS
			Nov 13, 16	13.2, 15.7	8 45.2 E			13.8, 15.2	.30040	21		W&S
			Nov 14, 16	18.2	8 41.4 E	11.5	0 58.8 S			21	21.(3(6)	W&S
			Nov 14, 16	18.7 to								
			Nov 15, 16	15.7 (dv)	8 42.5 E					21		W&S
			Nov 15, 16	17.3	8 43.6 E					21		W&S
			Dec 28, 16	10.3, 12.4	8 42.6 E	14.5	1 02.4 S	10.9, 12.0	.30192	21	21.(3(6)	W&S
			May 1, 17	8.1 to 17.4 (dv)	8 40.8 E					28		W&J
			May 7, 17	9.6, 11.5	8 39.0 E	12.2, 12.5	0 55.9 S	10.0, 10.8	.30148	28	EI 28	W&J
			Aug 8, 17					17.2	.30062	28		BJ
			Aug 9, 17	9.6	8 37.5 E	10.7, 11.0	0 59.4 S	9.2	.30008	28	EI 28	BJ
Lima, *B*	12 04.3 S	282 58	Feb 28, 18	10.0, 13.6	8 42.0 E			10.8, 13.0	.30113	5		C V
			Feb 28, 18	14.0, 17.3	8 41.4 E			14.6, 16.7	.30068	5		C V
			Mar 1, 18	9.7, 12.1	8 40.8 E			10.2, 11.6	.30199	5		C V
			Mar 1, 18	13.1, 15.4	8 43.7 E			13.6, 14.9	.30164	25		C V
			Mar 2, 18	8.0, 10.1	8 39.4 E			8.4, 9.7	.30134	25		C V
			Mar 2, 18	10.6, 12.7	8 45.1 E			11.1, 12.3	.30284	25		C V
			Mar 5, 18			11.6 to 15.9 (12)	0 45.7 S				EI 25	C V
			Mar 6, 18			9.5 to 12.3 (12)	0 45.9 S				EI 3	C V

[1] Magnetograph No. 2.

SOUTH AMERICA.

PERU—*Continued.*

Station	Latitude	Long. East of Gr.	Date	Declination		Inclination		Hor. Intensity		Instruments		Obs'r
				Local Mean Time	Value	L. M. T.	Value	L. M. T.	Value	Mag'r	Dip Circle	
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Lima, *B—Concluded*	12 04.3 S	282 58	Mar 7,'18	....	....	9.9 to 15.4 (9)	0 46.7 S	11.2,12.4	.30182	25	EI 25	C V
			Mar 7, 18	....	....	....	....	13.7,14.2	.30162	25	....	C V
			Mar 11, 18	....	....	9.7 to 15.5 (10)	0 45.3 S	10.9,11.8	.30140	25	EI 25	C V
			Mar 11, 18	....	....	....	....	13.9,14.3	.30070	25	....	C V
			Mar 13, 18	....	....	9.6 to 14.6 (10)	0 45.7 S	11.1,13.2	.30211	25	EI 25	C V
			Mar 14, 18	9.3, 9.6	8 40.0 E	....	....	....	....	5	....	C V
			Mar 14, 18	10.2,10.6	8 40.6 E	....	....	....	....	5	....	C V
			Mar 18, 18	....	....	13.4 to 14.8 (8)	0 45.5 S	....	....	....	EI 25	C V
Lima, *C*	12 04.3 S	282 58	Feb 28, 18	10.0,13.6	8 42.3 E	....	....	10.8,13.0	.30124	25	....	C V
			Feb 28, 18	14.0,17.3	8 41.8 E	....	....	14.6,16.7	.30076	25	....	C V
			Mar 1, 18	9.7,12.1	8 41.7 E	....	....	10.2,11.6	.30208	25	....	C V
			Mar 1, 18	13.1,15.4	8 42.9 E	....	....	13.6,14.9	.30144	5	....	C V
			Mar 2, 18	8.0,10.1	8 38.9 E	....	....	8.4, 9.7	.30149	5	....	C V
			Mar 2, 18	10.6,12.7	8 44.0 E	....	....	11.0,12.3	.30294	5	....	C V
			Mar 4, 18	9.4,11.0,13.2	8 41.9 E	....	....	9.8 to 16.0 (8)	.30180	25	....	C V
			Mar 4, 18	14.8,16.4	8 44.6 E	....	....	....	....	25	....	C V
			Mar 5, 18	....	....	11.6 to 15.9 (12)	0 46.4 S	....	....	....	EI 3	C V
			Mar 6, 18	....	....	9.5 to 12.3 (12)	0 45.9 S	....	....	....	EI 25	C V
			Mar 9, 18	6.5 to 8.5 (dv)	8 39.3 E	....	....	....	....	25	....	C V
			Mar 12, 18	9.3 to 18.3 (dv)	8 42.0 E	....	....	....	....	25	....	C V
			Mar 14, 18	9.3, 9.6	8 40.5 E	....	....	....	....	25	....	C V
			Mar 14, 18	10.2,10.6	8 42.0 E	....	....	....	....	25	....	C V
			Mar 14, 18	12.3,12.5,12.6	8 44.5 E	....	....	....	....	25	....	C V
			Mar 15, 18	....	....	....	....	9.5 to 15.9 (8)	.30170	25	....	C V
			Mar 19, 18	....	....	....	....	9.6 to 16.2 (8)	.30187	25	....	C V
Huancayo, *Primary*	12 04.5 S	284 46	Apr 12, 17	10.5,12.1	8 19.8 E	8.0, 8.3	0 08.4 S	10.9	.29932	28	EI 28	F&W
			Apr 15, 19	9.8,11.4	8 12.8 E	13.6,13.8	0 12.6 S	10.2,11.1	.29892	10	EI 5	E&R
Huancayo, *Secondary*	12 04.5 S	284 46	Apr 12, 17	12.7	8 20.0 E	....	....	....	....	28	....	F&W
			Apr 11, 19	14.4,16.3	8 14.0 E	....	....	15.0,15.9	.29738	10	....	E&R
			Apr 16, 19	....	....	15.4,15.6	0 11.7 S	....	....	....	EI 5	E&R
San Lorenzo Island	12 05.4 S	282 47	Mar 27, 14	10.5,12.1	8 58.7 E	13.9,15.3[1]	2 02.9 S	11.0,11.8	.30078	19	19.256	HRS
Pisco	13 42.4 S	283 46	Mar 7, 17	7.3,10.4	8 57.2 E	11.8,12.6	3 08.0 S	7.8,10.0	.29568	28	EI 28	DMW
Pisco, *E*	13 42.4 S	283 46	Mar 7, 17	15.2	9 01.3 E	....	....	....	....	28	....	DMW
Pisco, *N*	13 42.4 S	283 46	Mar 7, 17	15.8	9 01.9 E	....	....	....	....	28	....	DMW
Ica	14 04.7 S	284 14	Mar 5, 17	14.8,17.0	8 55.2 E	12.6,13.4	3 50.6 S	15.3,16.6	.29161	28	EI 28	DMW
Ica, *Secondary*	14 04.7 S	284 14	Mar 5, 17	18.6	8 51.2 E	....	....	....	....	28	....	DMW
Hacienda Huayta, *A**	15 29 S	289 35	Mar 27, 17	11.5,13.3	7 18.4 E	10.6,10.8	4 06.6 S	12.0,12.9	.28552	28	EI 28	JAF
Hacienda Huayta, *E**	15 29 S	289 35	Mar 28, 17	15.0	7 19.8 E	13.4	3 53.5 S	14.6	.28425	28	EI 28	JAF
Hacienda Huayta, *N**	15 29 S	289 35	Mar 28, 17	8.7	7 23.5 E	10.3	4 17.6 S	9.1	.28365	28	EI 28	JAF
Juliaca	15 30.0 S	289 51	Mar 31, 17	8.7,10.4	7 12.9 E	11.2,11.5	3 44.4 S	9.1,10.0	.28518	28	EI 28	JAF
Arequipa, *A*	16 22.5 S	288 27	Jan 5, 17	14.3,16.3	7 51.6 E	....	....	14.8,15.9	.28408	21	....	W&S
			Jan 6, 17	....	....	12.0	5 55.6 S	....	....	....	21. (3(56)	W&S
			Jan 7, 17	7.6 to 17.6 (dv)	7 51.2 E	....	....	....	....	21	....	W&S
			Jan 18, 17	15.2	7 50.7 E	....	....	15.9	.28430	21	....	AS
			Jan 19, 17	9.2,10.0	7 47.6 E	....	....	8.6,10.5	.28513	21	....	AS
			Jan 19, 17	15.0,15.5	7 51.7 E	....	....	14.0,16.0	.28466	21	....	AS
			Jan 20, 17	10.0	7 48.6 E	....	....	9.3	.28502	21	....	AS
			Jan 20, 17	11.3,14.8	7 51.0 E	....	....	13.0,14.3	.28465	10	....	DMW
			Jan 20, 17	15.3,17.2	7 49.4 E	....	....	15.8,16.7	.28431	10	....	DMW
			Jan 21, 17	8.1,10.1	7 50.5 E	....	....	8.6, 9.6	.28498	10	....	DMW
			Jan 24, 17	....	....	12.1,15.0	5 46.4 S	....	....	....	EI 5	DMW
			Jan 25, 17	....	....	10.4	5 45.2 S	....	....	....	EI 5	DMW
			Jan 25, 17	....	....	13.6,16.0	5 52.8 S	....	....	....	EI 5	DMW
			Jan 26, 17	....	....	10.8	5 49.2 S	....	....	....	EI 5	DMW
			Jan 30, 17	....	....	10.6	5 46.0 S	....	....	....	EI 5	DMW
			Jan 30, 17	....	....	14.6,16.8	5 50.4 S	....	....	....	EI 5	DMW
Arequipa, *B*	16 22.5 S	288 27	Jan 18, 17	15.2	7 58.6 E	....	....	16.0	.28461	10	....	DMW
			Jan 19, 17	9.2,10.0	7 55.1 E	....	....	8.6,10.6	.28510	10	....	DMW
			Jan 19, 17	15.0,15.5	7 59.8 E	....	....	14.0,16.0	.28490	10	....	DMW
			Jan 20, 17	10.0	7 56.3 E	....	....	9.3	.28507	10	....	DMW
			Jan 20, 17	11.3,14.9	7 58.3 E	....	....	13.0,14.3	.28470	21	....	AS
			Jan 20, 17	15.3,17.2	7 57.0 E	....	....	15.7,16.7	.28440	21	....	AS

* Local disturbance. [1] Needle No. 6 only at 15.3*h*.

SOUTH AMERICA.

PERU—*Concluded.*

Station	Latitude	Long. East of Gr.	Date	Declination		Inclination		Hor. Intensity		Instruments		Obs'r
				Local Mean Time	Value	L. M. T.	Value	L. M. T.	Value	Mag'r	Dip Circle	
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
requipa, *B—Concluded*	16 22.5 S	288 27	Jan 21,'17	8.0,10.0	7 57.8 E	....	....	8.6, 9.6	.28510	21	....	AS
			Jan 26, 17	....	....	15.0	6 07.4 S	....	....	......	EI 5	DMW
			Jan 27, 17	....	....	10.4	5 56.4 S	....	....	......	EI 5	DMW
			Jan 27, 17	....	....	14.0,16.2	6 07.2 S	....	....	......	EI 5	DMW
			Jan 28, 17	....	....	9.7,12.1	5 59.6 S	....	....	......	EI 5	DMW
itor, *N*	16 25.7 S	288 10	Mar 14, 17	10.5	7 25.0 E	....	....	....	....	28	....	DMW
itor	16 26.0 S	288 10	Mar 13, 17	14.8,16.8	7 25.6 E	....	....	15.1,16.3	.27994	28	....	DMW
			Mar 14, 17	....	....	7.8, 8.1	6 31.6 S	....	....	......	EI 28	DMW
			Mar 15, 17	6.9 to 17.8 (dv)	7 21.9 E	....	....	....	....	28	....	DMW
itor, *W*	16 26.1 S	288 10	Mar 14, 17	11.3	7 28.7 E	....	....	....	....	28	....	DMW
ollendo, *1912*	17 01.8 S	287 59	Apr 1, 14	10.2 to 13.8 (dv)	8 15.6 E	....	....	....	....	19	....	HRS
ollendo, *1917*	17 01.8 S	287 59	Jan 2, 17	9.5,11.6	8 04.8 E	14.8	7 38.1 S	10.0,11.2	.28062	21	21.(13(6)	AS

URUGUAY.

Station	Latitude	Long. East of Gr.	Date	Decl. L. M. T.	Decl. Value	Incl. L. M. T.	Incl. Value	H. I. L. M. T.	H. I. Value	Mag'r	Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
olon	34 48.3 S	303 46	Sep 9,'19	12.3,14.4	2 54.3 E	16.5	28 07.2 S	13.0,14.0	.24370	16	242.1256	AS

VENEZUELA.

Station	Latitude	Long. East of Gr.	Date	Decl. L. M. T.	Decl. Value	Incl. L. M. T.	Incl. Value	H. I. L. M. T.	H. I. Value	Mag'r	Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
aracas	10 30.4 N	293 04	Mar 23,'14	11.1,13.4	0 07.8 W	16.1	40 07.9 N	12.1,13.0	.30504	21	21.(343)	ADP
illa de Cura	10 02.2 N	292 30	Mar 26, 14	10.3,11.8	0 00.9 W	14.5	39 43.3 N	10.8,11.4	.30345	21	21.(343)4)	ADP
rtiz	9 37.5 N	292 43	Mar 29, 14	10.0,11.6	0 13.2 E	14.3	38 49.6 N	10.5,11.2	.30582	21	21.(34)4)	ADP
alaboza	8 56.1 N	292 34	Apr 1, 14	10.4,11.9	0 28.2 E	14.1	37 58.9 N	10.9,11.6	.30497	21	21.(343)4)	ADP
edana del Burro	8 24.6 N	292 25	Apr 3, 14	13.9,15.5	0 41.6 E	17.8	36 59.6 N	14.5,15.1	.30766	21	21.(343)4)	ADP
an Fernando de Apure	7 53.9 N	292 32	Apr 7, 14	10.3,11.8	0 50.3 E	15.2	36 33.4 N	10.8,11.5	.30558	21	21.(343)4)	ADP
pure River	7 39.8 N	293 17	Apr 15, 14	10.6,12.7	0 02.2 E	14.6	36 01.0 N	11.2,12.1	.30558	21	21.(343)4)	ADP
a Urbana	7 08.3 N	293 01	Apr 17, 14	16.5,17.9	0 37.8 E	....	....	17.0,17.6	.30490	21	....	ADP
			Apr 18, 14	....	....	7.9	35 24.2 N	....	....	......	21.(343)4)	ADP
uaramaco	6 14.6 N	292 33	Apr 23, 14	11.4,13.9	1 15.7 E	15.3	34 28.9 N	12.7,13.5	.30670	21	21.(343)4)	ADP

ISLANDS, ATLANTIC OCEAN.

CANARY ISLANDS.

Station	Latitude	Long. East of Gr.	Date	Decl. L. M. T.	Decl. Value	Incl. L. M. T.	Incl. Value	H. I. L. M. T.	H. I. Value	Mag'r	Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Santa Cruz	28 28.0 N	343 44	Feb 15,'14	13.9,16.0	14 28.7 W	11.5	47 57.6 N	14.5,15.6	.25724	16	222.1256	DMW
			Jun 8, 15	9.7,11.2	14 20.3 W	14.2	47 49.5 N	10.1,10.8	.25770	16	222.1256	DMW
Las Palmas	28 07.6 N	344 35	Jun 4, 15	14.3,15.6	17 01.2 W	12.4	46 25.0 N	14.7,15.4	.27346	16	222.1256	DMW

FERNANDO PO.

Station	Latitude	Long. East of Gr.	Date	Decl. L. M. T.	Decl. Value	Incl. L. M. T.	Incl. Value	H. I. L. M. T.	H. I. Value	Mag'r	Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Santa Isabel	3 46 N	8 47	May 2,'15	14.8,16.2	12 11.4 W	13.6	11 30.8 S	15.2,15.8	.31559	16	222.1256	DMW

ICELAND.

Station	Latitude	Long. East of Gr.	Date	Decl. L. M. T.	Decl. Value	Incl. L. M. T.	Incl. Value	H. I. L. M. T.	H. I. Value	Mag'r	Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Akranes*	64 18.8 N	337 54	Sep 3,'14	11.5,12.7	34 16.2 W	10.7,11.0	75 37.2 N	11.8,12.4	.13101	25	EI 25	C III
Kialarnes*	64 13.9 N	338 08	Sep 3, 14	15.7,16.9	30 15.6 W	17.5,17.7	76 06.6 N	16.0,16.6	.12451	25	EI 25	C III
Reykjavik, *A**	64 10.4 N	338 05	Aug 28, 14	8.9,10.8	44 18.6 W	....	....	9.4,10.4	.11673	5	....	C III
			Aug 28, 14	11.1,13.0	44 24.4 W	....	....	11.5,12.7	.11704	5	....	C III
			Aug 28, 14	13.9,16.2	44 16.7 W	....	....	14.7,15.9	.11736	5	....	C III
			Aug 29, 14	8.4,10.5	44 22.4 W	....	....	9.1,10.1	.11653	25	....	C III
			Aug 29, 14	10.8,12.7	44 22.9 W	....	....	11.1,12.4	.11704	25	....	C III
			Aug 29, 14	13.0,14.8	44 00.9 W	....	....	13.3,14.3	.11830	25	....	C III
			Aug 30, 14	....	....	8.8 to 12.8 (6)	77 00.2 N	9.9,10.7	.11686	25	EI 25	C III

* Local disturbance.

ISLANDS, ATLANTIC OCEAN.

ICELAND—*Concluded.*

Station	Latitude	Long. East of Gr.	Date	Declination		Inclination		Hor. Intensity		Instruments		Obs'r
				Local Mean Time	Value	L. M. T.	Value	L. M. T.	Value	Mag'r	Dip Circle	
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Reykjavik, *A**	64 10.4 N	338 05	Aug 30, '14	....	....	14.3 to 16.9 (6)	76 51.5 N	13.2 to 16.2 (4)	.11792	25	EI 25	C III
			Sep 1, 14	....	....	9.0 to 10.8 (8)	76 59.7 N	....	....	......	EI 25	C III
			Sep 1, 14	....	....	11.5 to 13.6 (9)	76 59.1 N	....	....	......	EI 3	C III
			Sep 2, 14	8.5 to 16.2 (9)	44 18.2 W	....	....	9.0 to 16.9 (7)	.11695	5	....	C III
			Sep 3, 14	8.1 to 17.2 (9)	44 18.1 W	....	....	8.6 to 16.8 (8)	.11686	5	....	C III
			Sep 4, 14	8.2 to 15.0 (5)	44 17.2 W	....	....	8.5 to 15.4 (9)	.11702	5	....	C III
			Sep 9, 14	11.5 to 13.3 (4)	44 20.4 W	....	....	....	....	25	....	C III
			Sep 9, 14	14.0,14.5,15.0	44 14.7 W	....	....	....	....	5	....	C III
Reykjavik, *B**	64 10.4 N	338 05	Aug 26, 14	14.4	43 01 W	....	....	....	....	*189*	....	C III
			Sep 9, 14	11.4	43 03 W	11.4	77 21 N	11.4	*.1138*	*189*	189.7	C III
Reykjavik, *C**	64 10.4 N	338 05	Aug 26, 14	14.7,15.1	42 14 W	....	....	....	....	*189*	....	C III
			Sep 9, 14	10.8	42 29 W	10.9	77 21.1 N	10.9	*.1133*	*189*	189.7	C III
Reykjavik, *D**	64 10.4 N	338 05	Aug 26, 14	15.4	44 37 W	....	....	....	....	*189*	....	C III
			Sep 9, 14	10.1	44 39 W	10.2	77 31.2 N	10.2	*.1146*	*189*	189.7	C III
Reykjavik, *E**	64 10.4 N	338 05	Aug 28, 14	8.9,10.8	42 40.8 W	....	....	9.4,10.4	.11861	25	....	C III
			Aug 28, 14	11.1,13.0	42 46.2 W	....	....	11.5,12.7	.11892	25	....	C III
			Aug 28, 14	13.9,16.2	42 44.3 W	....	....	14.6,15.8	.11923	25	....	C III
			Aug 29, 14	8.4,10.5	42 44.4 W	....	....	9.0,10.1	.11857	5	....	C III
			Aug 29, 14	10.8,12.7	42 45.0 W	....	....	11.1,12.5	.11887	5	....	C III
			Aug 29, 14	13.0,14.8	42 24.8 W	....	....	13.3,14.3	.12006	5	....	C III
			Aug 31, 14	....	....	8.6 to 15.6 (12)	76 53.9 N	9.4 to 15.0 (6)	.11882	25	EI 25	C III
			Sep 1, 14	14.1 to 19.0 (dv)	42 34.2 W	9.0 to 10.8 (8)	76 54.3 N	....	....	25	EI 3	C III
			Sep 1, 14	....	....	11.5 to 13.6 (9)	76 54.0 N	....	....	......	EI 25	C III
			Sep 8, 14	8.3 to								
			Sep 9, 14	8.6 (dv)......	42 39.7 W	....	....	....	....	5	....	C III
			Sep 9, 14	11.5,11.9	42 44.1 W	....	....	....	....	5	....	C III
			Sep 9, 14	12.8,13.3	42 42.0 W	....	....	....	....	5	....	C III
			Sep 9, 14	14.0,14.5,15.0	42 37.2 W	....	....	....	....	25	....	C III
Videy Island*	64 10.4 N	338 08	Sep 9, 14	14.2	44 09 W	14.6	79 37.5 N	14.6	*.0928*	*189*	189.7	C III
Grotta*	64 09.7 N	337 59	Sep 2, 14	9.7,11.1	35 23.0 W	11.9,12.2	76 35.4 N	10.1,10.8	.12236	25	EI 25	C III

MADEIRAS.

Station	Latitude	Long. East of Gr.	Date	Declination L. M. T.	Declination Value	Inclination L. M. T.	Inclination Value	Hor. Intensity L. M. T.	Hor. Intensity Value	Mag'r	Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Funchal, *A**	32 38.0 N	343 05	Feb 9, '14	....	....	13.0	53 33.2 N	....	....	......	222.1256	DMW
Funchal, *C**	32 37.2 N	343 04	Feb 10, 14	10.3,11.1	20 09.2 W	....	....	10.9,11.7	.25544	16	....	DMW
			Feb 10, 14	16.4	16 34 W	....	....	16.9,17.8	.25078	16	....	DMW
			Feb 11, 14	....	....	8.3	53 29.7 N	....	....	......	222.12	DMW

ST. HELENA.

Station	Latitude	Long. East of Gr.	Date	Declination L. M. T.	Declination Value	Inclination L. M. T.	Inclination Value	Hor. Intensity L. M. T.	Hor. Intensity Value	Mag'r	Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Longwood, *A*	15 56.7 S	354 19	Mar 30, '20	10.8,13.9	25 07.2 W	15.4,15.7	38 20.8 S	11.5,13.4	.21732	25	EI 25	C VI

SOUTH GEORGIA.

Station	Latitude	Long. East of Gr.	Date	Declination L. M. T.	Declination Value	Inclination L. M. T.	Inclination Value	Hor. Intensity L. M. T.	Hor. Intensity Value	Mag'r	Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Edwards Point	54 18 S	323 34	Jan 13, '16	9.2,10.8	4 23.5 W	11.4,11.6	49 15.2 S	9.6,10.4	.24056	25	EI 25	C IV

WEST INDIES.

Station	Latitude	Long. East of Gr.	Date	Declination L. M. T.	Declination Value	Inclination L. M. T.	Inclination Value	Hor. Intensity L. M. T.	Hor. Intensity Value	Mag'r	Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Havana	23 06.4 N	277 39	Oct 5, '16	10.1,12.8	3 13.0 E	....	....	10.7,12.4	.29030	21	....	W&S
Kingston	17 58.9 N	283 11	Mar 12, 14	10.2,11.6	1 11.8 E	12.9	48 50.0 N	10.6,11.3	.30396	19	19.56	HRS
Bridgetown	13 04.8 N	300 21	Jul 28, 19	6.5, 7.7	5 42.0 W	8.7, 8.9	45 14.2 N	6.8, 7.4	.28842	28	EI 28	DMW

* Local disturbance.

ISLANDS, INDIAN OCEAN.

CEYLON.

Station	Latitude	Long. East of Gr.	Date	Declination: Local Mean Time	Declination: Value	Inclination: L. M. T.	Inclination: Value	Hor. Intensity: L. M. T.	Hor. Intensity: Value	Instruments: Mag'r	Instruments: Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Colombo, A*	6 54.2 N	79 52	Oct 29, '18	16.3,17.7	2 20.8 W	....	....	16.7,17.4	.38222	17	....	HES
			Oct 30, 18	....	....	6.8	4 15.3 S	....	....	......	223.1356	HES
			Jul 6, 20	8.6,12.0,12.4	2 29.4 W	....	....	9.3,11.5	.38418	25	....	C VI
			Jul 6, 20	....	....	....	....	13.0,14.3	.38389	25	....	C VI
			Jul 6, 20	14.8,15.4,17.4	2 28.7 W	....	....	15.9,17.0	.38329	25	....	C VI
			Jul 7, 20	8.6, 9.8,10.3	2 28.1 W	....	....	....	....	25	....	C
			Jul 7, 20	10.8,13.6	2 29.0 W	....	....	11.5,12.9	.38392	5	....	C VI
			Jul 7, 20	14.8,17.0	2 28.9 W	....	....	15.8	.38345	5	....	C VI
			Jul 8, 20	10.1,11.7,12.2	2 29.2 W	....	....	9.3,10.5	.38406	5	....	C VI
			Jul 8, 20	....	....	....	....	11.4	.38407	5	....	C VI
			Jul 12, 20	....	....	10.1 to 16.5 (10)	4 11.6 S	....	....	......	EI 25	C VI
			Jul 13, 20	....	....	8.5 to 11.1 (7)	4 09.3 S	....	....	......	EI 7	C VI
			Jul 15, 20	15.4 to 17.1 (6)	2 27.7 W	....	....	....	....	25	....	C VI
			Jul 19, 20	8.8 to 10.2 (5)	2 28.1 W	....	....	....	....	25	....	C VI
Colombo, C*	6 54.2 N	79 52	Jul 6, 20	8.6,12.0,12.4	2 31.7 W	....	....	9.4,11.5	.38436	5	....	C VI
			Jul 6, 20	....	....	....	....	13.0,14.3	.38370	5	....	C VI
			Jul 6, 20	14.8,15.4,17.4	2 29.3 W	....	....	15.9,17.0	.38340	5	....	C VI
			Jul 7, 20	8.6, 9.8,10.3	2 28.4 W	....	....	....	....	5	....	C VI
			Jul 7, 20	10.8,13.6	2 29.7 W	....	....	11.4,12.9	.38422	25	....	C VI
			Jul 7, 20	14.8,17.0	2 29.6 W	....	....	15.8	.38364	25	....	C VI
			Jul 8, 20	10.1,11.7,12.2	2 30.6 W	....	....	9.3,10.5	.38402	25	....	C VI
			Jul 8, 20	....	....	....	....	11.4	.38413	25	....	C VI
			Jul 8, 20	....	....	....	....	13.1,13.7	.38355	25	....	C VI
			Jul 8, 20	....	....	....	....	14.7,15.8	.38336	25	....	C VI
			Jul 9, 20	....	....	....	....	8.4, 9.5	.38386	25	....	C VI
			Jul 9, 20	....	....	....	....	10.2,11.3	.38406	25	....	C VI
			Jul 9, 20	15.6 to 17.8 (dv)	2 29.4 W	....	....	12.6,18.3	.38398	25	....	C VI
			Jul 10, 20	6.6 to 8.7 (dv)	2 28.4 W	....	....	....	....	25	....	C VI
			Jul 12, 20	....	....	10.1 to 16.5 (10)	4 20.0 S	....	....	......	EI 7	C VI
			Jul 13, 20	....	....	8.6 to 11.1 (7)	4 17.3 S	....	....	......	EI 25	C VI
			Jul 13, 20	....	....	14.4 to 16.6 (4)	4 20.5 S	15.2,15.8	.38367	25	EI 25	C VI
			Jul 14, 20	6.8 to 8.2 (dv)	2 27.9 W	9.4 to 16.7 (10)	4 19.3 S	10.3	.38419	25	EI 25	C VI
			Jul 14, 20	....	....	....	....	15.7,16.3	.38348	25	....	C VI
			Jul 20, 20	16.2 to 18.0 (dv)	2 29.1 W	....	....	....	....	25	....	C VI

MADAGASCAR.

Station	Latitude	Long. East of Gr.	Date	Declination: Local Mean Time	Declination: Value	Inclination: L. M. T.	Inclination: Value	Hor. Intensity: L. M. T.	Hor. Intensity: Value	Instruments: Mag'r	Instruments: Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Majunga, A	15 42.9 S	46 19	Oct 18, '20	9.6,11.0	6 42.8 W	14.0	49 53.8 S	10.0,10.7	.23388	13	177.2X(78)	FB
Majunga, B	15 43.4 S	46 19	Oct 15, 20	10.3,11.6	6 36.8 W	15.9	49 53.3 S	10.6,11.3	.23398	13	177.2X(78)[1]	FB
			Oct 16, 20	5.8 to 18.1 (dv)	6 36.7 W	....	....	....	....	13	....	FB
Maevatanana, A	16 56.4 S	46 48	Oct 24, 20	9.4,10.8	6 55.8 W	7.8	51 25.2 S	9.8,10.5	.22588	13	177.2X(8)	FB
Maevatanana, B	16 56.9 S	46 48	Oct 25, 20	9.3,10.7	6 59.0 W	7.7	51 26.5 S	9.7,10.4	.22608	13	177.2X(78)	FB
Antsiafabositra	17 18.4 S	46 56	Oct 27, 20	16.1,17.4	7 02.4 W	....	....	16.4,17.2	.22514	13	....	FB
			Oct 28, 20	....	....	7.7	51 53.5 S	....	....	......	177.2X(78)	FB
Andriba	17 36.3 S	46 54	Oct 29, 20	16.9,17.8	7 14.8 W	16.0	52 07.4 S	17.4	.22223	13	177.2X(7)[1]	FB
Mahatsinjo	17 44.3 S	47 00	Oct 30, 20	16.3,17.6	7 04.2 W	....	....	16.7,17.3	.22139	13	....	FB
			Oct 31, 20	....	....	6.9	52 38.9 S	....	....	......	177.2X(78)[1]	FB
Ankazobe	18 18.9 S	47 06	Nov 4, 20	....	....	17.1	52 55.0 S	....	....	......	177.2X(78)	FB
			Nov 5, 20	8.3, 9.6	7 24.9 W	....	....	8.7, 9.4	.21812	13	....	FB
Fihaonana	18 36.2 S	47 11	Nov 9, 20	7.1, 8.5	7 57.4 W	10.2	53 08.6 S	7.4, 8.2	.21825	13	177.2X(78)	FB
Tananarive	18 54.9 S	47 30	Nov 22, 20	9.5,11.5	8 05.4 W	13.5	53 09.9 S	9.9,11.2	.21900	13	177.2X(78)	FB
Tananarive Observatory, A*	18 55.0 S	47 32	Nov 13, 20	....	....	13.2,15.2	53 16.5 S	....	....	......	177.2X(78)	FB
			Nov 15, 20	....	....	9.5,10.9	53 17.4 S	....	....	......	177.2X(78)	FB
			Nov 15, 20	....	....	14.9,16.2	53 17.7 S	....	....	......	177.2X(78)	FB
			Nov 16, 20	13.0,14.4	7 49.8 W	6.2	53 18.2 S	13.4,14.1	.22044	13	177.2X(78)	FB
			Nov 17, 20	7.2, 8.8	7 56.3 W	....	....	7.7, 8.4	.22048	13	....	FB
			Nov 17, 20	9.0,10.5	7 57.0 W	....	....	9.4,10.1	.22052	13	....	FB
			Nov 18, 20	....	....	8.4	53 17.6 S	....	....	......	177.2X(78)	FB
Tananarive Observatory, B*	18 55.0 S	47 32	Nov 12, 20	10.0,13.1	7 55.0 W	....	....	10.6,11.3	.21018	13	....	FB
			Nov 13, 20	7.2, 8.6	7 59.6 W	....	....	7.6, 8.2	.20974	13	....	FB
			Nov 13, 20	8.8,10.0	7 59.8 W	....	....	9.2, 9.7	.20970	13	....	FB
			Nov 16, 20	10.5,10.7	8 00.2 W	....	....	....	....	13	....	FB

* Local disturbance. [1] 13X rejected.

ISLANDS, INDIAN OCEAN.

MADAGASCAR—*Concluded.*

Station	Latitude	Long. East of Gr.	Date	Declination		Inclination		Hor. Intensity		Instruments		Obs'r
				Local Mean Time	Value	L. M. T.	Value	L. M. T.	Value	Mag'r	Dip Circle	
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Betafo	19 50.0 S	46 50	Nov 27, '20	6.9, 8.3	8 32.1 W	10.8	54 08.2 S	7.3, 8.0	.21328	13	177.2X(78)	FB
Antsirabe, *B*	19 51.9 S	47 00	Nov 28, 20	6.6, 7.9	8 35.8 W	9.3	54 20.4 S	7.0, 7.6	.21184	13	177.2X(78)[1]	FB
Antsirabe, *A*	19 52.2 S	47 00	Nov 26, 20	6.6, 8.0	8 26.5 W	14.3	54 38.0 S	7.0, 7.7	.21047	13	177.2X(78)	FB
Ambositra, *A*	20 31.8 S	47 13	Nov 30, 20	6.6, 8.0	9 09.2 W	11.2	54 50.6 S	7.0, 7.7	.20929	13	177.2X(78)[1]	FB
			Nov 30, 20	....	....	14.8	54 53.8 S	....	....	.....	177.2X(8)[2]	FB
			Dec 1, 20	5.9 to 18.1 (dv)	9 05.4 W	....	....	....	....	13	....	FB
Ambositra, *B*	20 32.4 S	47 14	Dec 2, 20	8.2, 9.6	9 27.6 W	11.1	54 55.3 S	8.6, 9.3	.20898	13	177.2X(78)[1]	FB
Fianarantsoa, *A**	21 27.2 S	47 03	Dec 6, 20	7.8, 9.1	8 48.2 W	16.6	56 33.5 S	8.1, 8.8	.20056	13	177.2X(78)	FB
Fianarantsoa, *B**	21 27.2 S	47 02	Dec 7, 20	9.8, 11.4	9 37.9 W	15.8	55 59.3 S	10.2, 11.1	.20238	13	177.2X(78)	FB
Ambalavao	21 49 S	46 54	Dec 10, 20	6.0, 8.6	9 52.6 W	12.0	56 30.2 S	6.4, 7.0	.19986	13	177.2X(78)	FB
Zazafotsy	22 12 S	46 20	Dec 12, 20	....	....	17.8	57 38.4 S	....	....	.....	177.2X(78)	FB
			Dec 13, 20	5.5, 6.2	9 01.4 W	....	....	5.8	.19582	13	....	FB
Ihosy	22 23.8 S	46 07	Dec 14, 20	7.8, 9.2	10 30.6 W	10.8	57 10.6 S	8.2, 8.9	.19656	13	177.2X(78)	FB
Lalana	22 55.0 S	46 06	Dec 16, 20	9.4, 10.8	10 54.6 W	13.2	57 34.0 S	9.8, 10.5	.19538	13	177.2X(78)[2]	FB
Betroka	23 15.9 S	46 04	Dec 17, 20	....	....	15.9	58 05.7 S	....	....	.....	177.2X(78)[3]	FB
			Dec 18, 20	6.1 to 18.1 (dv)	10 26.5 W	....	....	....	....	13	....	FB
			Dec 19, 20	8.2, 9.6	10 32.0 W	....	....	8.6, 9.3	.19254	13	....	FB
Ankatrafay	23 20 S	45 38	Dec 21, 20	10.7, 11.5	10 36.9 W	13.0	57 43.8 S	11.0	.19398	13	177.2X(78)	FB
Tulear, *A*	23 21.2 S	43 37	Dec 31, 20	16.4, 17.9	10 49.8 W	....	....	16.9, 17.6	.19075	13	....	FB
			Jan 1, 21	6.0 to 18.1 (dv)	10 55.5 W	....	....	....	....	13	....	FB
			Jan 2, 21	....	....	8.1	58 16.6 S	....	....	.....	177.2X(78)[4]	FB
Tulear, *B*	23 21.6 S	43 37	Jan 4, 21	6.9, 8.3	10 53.6 W	17.3	58 20.4 S	7.3, 8.0	.19097	13	177.2X(78)[4]	FB
Ampasindrasoa	23 24 S	45 11	Dec 22, 20	15.9, 16.7	10 41.1 W	18.1	57 57.7 S	16.2	.19218	13	177.2X(78)[1]	FB
Benenitra	23 27.5 S	45 03	Dec 23, 20	....	....	18.0	58 06.3 S	....	....	.....	177.2X(78)[4]	FB
			Dec 24, 20	6.3, 7.7	10 58.3 W	....	....	6.7, 7.4	.19195	13	....	FB
Tongobory	23 32 S	44 17	Dec 28, 20	7.4, 8.8	11 05.6 W	15.7	58 19.4 S	7.8, 8.5	.19056	13	177.2X(8)[4]	FB

ISLANDS, PACIFIC OCEAN.

BISMARCK ARCHIPELAGO.

	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Rabaul	4 12.7 S	152 12	Dec 9, '15	12.5, 13.8	6 20.2 E	15.9	19 24.2 S	12.9, 13.6	.36456	14	14.1256	WCP

EASTER ISLAND.

	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Cook Bay	27 08.0 S	250 35	Dec 27, '16	11.4, 13.8	14 40.0 E	15.6, 15.8	38 30.2 S	11.9, 13.3	.30762	25	EI 25	C IV
			Dec 29, 16 Dec 30, 16	7.2 to 7.7 (dv)........	14 36.6 E	....	....	....	....	25	....	C IV

ELLICE ISLANDS.

	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Nanomea Island	5 39.8 S	176 07	Jun 9, '15	9.8, 11.1	9 04.2 E	15.2	16 09.7 S	10.1, 10.8	.36052	14	14.1256	WCP
Niutao Island	6 06.5 S	177 20	Jun 10, 15	13.7, 15.7	8 50.8 E	11.2	15 25.0 S	14.0, 15.4	.36590	14	14.1256	WCP
Nanomana Island	6 17.6 S	176 20	Jun 8, 15	9.4, 16.1	8 50.8 E	15.4	16 34.2 S	9.9, 10.5	.36510	14	14.1256	WCP
Nui Island	7 13.9 S	177 10	Jun 7, 15	14.8, 16.0	9 08.0 E	14.0	18 38.8 S	15.2, 15.7	.36231	14	14.1256	WCP
Vaitupu Island	7 29.4 S	178 40	Jun 2, 15	15.4, 16.4	9 01.1 E	10.7	18 38.3 S	15.7, 16.1	.36280	14	14.1256	WCP
Nukufetau Island	8 00.7 S	178 24	Jun 3, 15	14.1	9 04.0 E	15.2	20 00.4 S	14.4	.36363	14	14.12	WCP
Funafuti Island, *B*	8 30.7 S	179 12	Jun 5, 15	14.3, 15.5	8 58.7 E	11.3	20 49.6 S	14.6, 15.2	.35487	14	14.1256	WCP
Funafuti Island, *A*	8 30.9 S	179 12	Jun 1, 15	14.2	9 01.0 E	....	....	14.6	.35475	14	....	WCP
Nukulailai	9 21.9 S	179 50	Jun 4, 15	....	....	13.9	22 09.2 S	15.6	.35355	14	14.1256	WCP

FIJI ISLANDS.

	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Suva, Dr. Klotz's Station	18 08.8 S	178 26	May 8, '15	10.8, 12.2	10 16.8 E	13.1	38 20.4 S	11.2, 11.8	.34846	14	14.1256	WCP

* Local disturbance. [1] 13X rejected. [2] 13X only. [3] 14X rejected. [4] 15X used instead of 13X.

ISLANDS, PACIFIC OCEAN.

GILBERT ISLANDS.

Station	Latitude	Long. East of Gr.	Date	Declination		Inclination		Hor. Intensity		Instruments		Obs'r
				Local Mean Time	Value	L. M. T.	Value	L. M. T.	Value	Mag'r	Dip Circle	
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Maraki Island	2 00.2 N	173 16	Jul 2, '15	9.2	8 54.1 E	10.4	2 11.6 S	9.5	.35382	14	14.12	WCP
Apaiang Island	1 51.0 N	173 00	Jul 1, 15	16.2,17.5	8 46.4 E	14.1	1 49.9 S	16.5,17.2	.35396	14	14.1256	WCP
Tarawa Island	1 21.2 N	172 55	Jul 3, 15	11.5,12.9	8 55.0 E	13.7	3 13.3 S	11.8,12.6	.35319	14	14.1256	WCP
Nonuti Atoll	0 47.7 S	174 28	Jun 25, 15	15.4	8 32.5 E	16.6	6 29.2 S	15.9	.35631	14	14.12	WCP
Ocean Island	0 52.8 S	169 32	Jun 29, 15	14.1,15.3	8 17.1 E	13.1	7 03.3 S	14.4,15.0	.35440	14	14.1256	WCP
Tapeteuea Island	1 13.4 S	174 46	Jun 24, 15	15.1	8 47.0 E	14.7	6 57.4 S	13.1	.35214	14	14.12	WCP
Peru Island	1 18.7 S	176 01	Jun 14, 15	14.4,15.5	8 38.0 E	....	....	14.7,15.2	.35534	14	....	WCP
			Jun 21, 15	9.1	8 38.1 E	11.2	7 47.7 S	....	....	14	14.1256	WCP
Nukunau Island	1 19.9 S	176 26	Jun 15, 15	8.8	8 48.3 E	11.2	6 45.9 S	9.4,10.0	.35577	14	14.1256	WCP
Onoatoa Island	1 47.8 S	175 33	Jun 23, 15	15.0	8 57.3 E	11.3	8 09.6 S	15.9,16.4	.36085	14	14.1256	WCP
Tamana Island	2 30.2 S	176 00	Jun 19, 15	9.7,11.6	8 21.2 E	13.9	9 06.2 S	10.8,11.4	.36033	14	14.1256	WCP
Arorai Island	2 38.7 S	176 50	Jun 17, 15	9.6	8 38.2 E	14.5	8 43.7 S	10.1,10.6	.36162	14	14.1256	WCP

HAWAIIAN ISLANDS.

Station	Latitude	Long. East of Gr.	Date	Decl. L. M. T.	Decl. Value	Incl. L. M. T.	Incl. Value	H. I. L. M. T.	H. I. Value	Mag'r	Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Sisal, Honolulu Magnetic Observatory, *Pier A*	21 19.2 N	201 56	Jun 3, '15	9.9,12.0,13.9	9 41.1 E	....	....	10.4,11.6	.29028	5	....	C IV
			Jun 3, 15	16.0,16.5,18.6	9 41.4 E	....	....	14.4,15.6	.29029	5	....	C IV
			Jun 3, 15	....	....	....	....	17.0,18.1	.29011	5	....	C IV
			Jun 4, 15	9.8,12.0,12.5	9 41.3 E	....	....	10.3,11.6	.29011	25	....	C IV
			Jun 4, 15	16.3,16.8	9 40.6 E	....	....	14.8,15.8	.29022	25	....	C IV
			Jun 4, 15	....	....	....	....	17.3	.29014	25	....	C IV
			Jun 5, 15	9.3, 9.5	9 43.4 E	....	....	8.8	.29025	25	....	C IV
			Jun 5, 15	11.4,14.3	9 41.5 E	....	....	11.8,13.9	.29014	25	....	C IV
			Jun 21, 15	....	....	12.2 to						
						16.3 (6)	39 31.6 N	....	....	....	EI 25	C IV
			Jun 21, 15	....	....	17.7 (4)	39 33.5 N	....	....	....	EI 25	C IV
			Jun 22, 15	....	....	13.7 to						
						17.9 (8)	39 31.5 N	....	....	....	EI 3	C IV
			Jun 23, 15	....	....	10.5 to		11.3,12.0	.28979	25	....	C IV
						17.1 (5)	39 31.4 N	15.4,16.4	.28984	25	EI 25	C IV
			Jun 24, 15	....	....	8.3 to		9.5,11.7	.29002	25	....	C IV
						16.9 (11)	39 29.5 N	14.0	.29017	25	EI 25	C IV
			Jun 24, 15	....	....	....	....	15.4,16.0	.29014	25	....	C IV
			Jun 25, 15	....	....	9.1 to		9.6,11.1	.28987	25	....	C IV
						15.8 (10)	39 30.5 N	12.4	.28996	25	EI 25	C IV
			Jun 26, 15	....	....	9.0 (4)	39 30.2 N	....	....	....	EI 25	C IV
Sisal, *A*	21 19.2 N	201 56	May 27, 15	10.4,13.0	9 41.0 E	....	....	11.0,12.5	.28992	25	....	C IV
			May 27, 15	16.0,18.0	9 41.3 E	....	....	16.4,17.4	.28978	25	....	C IV
			May 28, 15	8.9,11.0	9 41.6 E	....	....	9.3,10.5	.28998	25	....	C IV
			May 28, 15	11.5,14.7	9 39.0 E	....	....	11.9,14.3	.29009	25	....	C IV
			Jun 4, 15	9.8,12.0	9 41.7 E	....	....	10.3,11.6	.29002	5	....	C IV
			Jun 4, 15	12.5,16.3,16.8	9 39.9 E	....	....	14.8,15.8	.29006	5	....	C IV
			Jun 4, 15	....	....	....	....	17.3	.29013	5	....	C IV
			Jun 5, 15	9.3, 9.5	9 43.0 E	....	....	8.8,11.8	.29026	5	....	C IV
			Jun 5, 15	....	....	....	....	13.9	.29012	5	....	C IV
			Jun 18, 15	....	....	13.9 to						
						17.6 (6)	39 34.4 N	....	....	....	EI 3	C IV
			Jun 19, 15	....	....	12.5 to						
						15.9 (6)	39 32.4 N	....	....	....	EI 25	C IV
			Jun 19, 15	....	....	16.6	39 33.2 N	....	....	....	EI 3	C IV
			Jun 26, 15	....	....	10.3 to						
						14.3 (12)	39 31.1 N	....	....	....	EI 3	C IV
Sisal, *B*	21 19.2 N	201 56	May 26, 15	16.4 to 18.6 (dv)	9 40.8 E	....	....	....	....	5	....	C IV
			May 27, 15	10.4,13.0	9 42.0 E	....	....	11.0,12.4	.29022	5	....	C IV
			May 27, 15	16.0,18.0	9 41.8 E	....	....	16.4,17.4	.29007	5	....	C IV
			May 28, 15	8.9,11.0	9 41.5 E	....	....	9.3,10.4	.29029	5	....	C IV
			May 28, 15	11.4,14.7	9 39.2 E	....	....	11.8,14.2	.29028	5	....	C IV
			May 29, 15	6.5 to 8.2 (dv)	9 46.0 E	....	....	10.4,11.1	.29033	5	....	C IV
			May 29, 15	10.0,11.7	9 42.3 E	....	....	12.1,12.7	.29032	5	....	C IV
			May 29, 15	13.2,14.3	9 37.6 E	....	....	14.6	.29032	5	....	C IV
			May 31, 15	8.6 to 17.2 (6)	9 41.4 E	....	....	9.1 to				
								17.8 (9)	.29018	5	....	C IV
			Jun 1, 15	10.9 to 17.8 (5)	9 40.8 E	....	....	11.3 to				
								17.4 (8)	.29025	5	....	C IV
			Jun 2, 15	9.3,10.6	9 42.2 E	....	....	9.6,10.3	.29040	5	....	C IV
			Jun 2, 15	12.0 to 16.3 (dv)	9 39.5 E	....	....	....	....	5	....	C IV
			Jun 3, 15	5.8 to 7.0 (dv)	9 43.5 E	....	....	10.4,11.6	.29030	25	....	C IV
			Jun 3, 15	9.9,12.0,13.9	9 41.2 E	....	....	14.4,15.5	.29030	25	....	C IV
			Jun 3, 15	16.0,16.5,18.6	9 41.7 E	....	....	17.0,18.2	.29022	25	....	C IV
			Jun 9, 15	....	....	....	....	15.7,17.3	.29017	25	....	C IV
			Jun 10, 15	10.0 to 17.4 (6)	9 41.9 E	....	....	10.4 to				
								17.1 (8)	.29040	5	....	C IV

ISLANDS, PACIFIC OCEAN.

HAWAIIAN ISLANDS—*Concluded.*

Station	Latitude	Long. East of Gr.	Date	Declination: Local Mean Time	Declination: Value	Inclination: L. M. T.	Inclination: Value	Hor. Intensity: L. M. T.	Hor. Intensity: Value	Instruments: Mag'r	Instruments: Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Sisal, *B*—*Concluded*	21 19.2 N	201 56	Jun 12, '15	15.0 to 18.6 (dv)	9 39.9 E	....	....	....	....	5	....	C IV
			Jun 14, 15	8.4 to 17.7 (6)	9 41.1 E	....	....	8.7 to 17.3 (10)	.29015	5	....	C IV
			Jun 15, 15	8.5 to 15.1 (4)	9 41.5 E	....	....	8.9 to 14.6 (6)	.29032	5	....	C IV
			Jun 16, 15	7.8 to 17.1 (dv)	9 40.5 E	....	....	....	....	25	....	C IV
			Jun 17, 15	7.6 to 8.7 (dv)	9 43.5 E	....	....	....	....	25	....	C IV
			Jun 17, 15	10.0 to 14.5 (dv)	9 37.4 E	....	....	....	....	5	....	C IV
			Jun 17, 15	14.8 to 17.5 (dv)	9 38.4 E	....	....	....	....	25	....	C IV
			Jun 22, 15	....	....	....	....	8.4, 9.3	.28972	25	....	C IV
			Jun 23, 15	6.1 to 8.2 (dv)	9 44.6 E	....	....	....	....	25	....	C IV

LORD HOWE ISLAND.

Station	Latitude	Long. East of Gr.	Date	Declination: Local Mean Time	Declination: Value	Inclination: L. M. T.	Inclination: Value	Hor. Intensity: L. M. T.	Hor. Intensity: Value	Instruments: Mag'r	Instruments: Dip Circle	Obs'r
	° ′	° ′		h h h	°	h h	° ′	h h	c. g. s.			
Lord Howe Island	31 31.1 S	159 04	Mar 22, '15	11.5	11.2[1] E	12.6	59 15.3 S	11.8	.28414	14	14.12	WCP

MARIANAS (LADRONE ISLANDS).

Station	Latitude	Long. East of Gr.	Date	Declination: Local Mean Time	Declination: Value	Inclination: L. M. T.	Inclination: Value	Hor. Intensity: L. M. T.	Hor. Intensity: Value	Instruments: Mag'r	Instruments: Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Guam, Cabras Island	13 28 N	144 40	Aug 2, '16	9.3,10.6	2 00.0 E	11.5,11.7	14 03.6 N	9.7,10.3	.35042	25	EI 25	C IV
Guam, Oroté Point	13 37 N	144 37	Jul 26, 16	10.0,11.3	1 56.8 E	12.5,12.9	14 05.4 N	10.4,11.0	.34953	25	EI 25	C IV
Guam, Sumay, *A*	13 26.2 N	144 39	Jul 20, 16	10.5,13.2	1 58.8 E	....	....	11.0,12.8	.34961	5	....	C IV
			Jul 20, 16	14.4,16.3	1 58.3 E	....	....	14.8,15.9	.34924	5	....	C IV
			Jul 21, 16	8.9,11.0	1 59.9 E	....	....	9.4,10.6	.34974	5	....	C IV
			Jul 21, 16	11.6,14.0	1 58.8 E	....	....	12.0,13.7	.34982	25	....	C IV
			Jul 21, 16	14.5,16.2	1 58.4 E	....	....	14.9,15.8	.34944	25	....	C IV
			Jul 22, 16	8.8,10.6	2 00.4 E	....	....	9.2,10.2	.34977	25	....	C IV
			Jul 24, 16	....	....	11.3 (3)	14 04.3 N	....	....	......	EI 3	C IV
			Jul 24, 16	....	....	14.7 to 17.1 (6)	14 02.6 N	....	....	......	EI 3	C IV
			Jul 25, 16	....	....	11.4 (4)	14 01.9 N	....	....	......	EI 3	C IV
			Jul 25, 16	....	....	14.0 to 16.3 (8)	14 02.2 N	....	....	......	EI 25	C IV
			Jul 28, 16	....	....	14.8 (4)	14 03.6 N	....	....	......	EI 25	C IV
Guam, Sumay, *B*	13 26.2 N	144 39	Jul 20, 16	10.5,13.2	1 58.6 E	....	....	11.0,12.8	.34960	25	....	C IV
			Jul 20, 16	14.4,16.3	1 56.8 E	....	....	14.8,15.9	.34944	25	....	C IV
			Jul 21, 16	8.9,11.0	2 00.7 E	....	....	9.4,10.6	.34968	25	....	C IV
			Jul 21, 16	11.6,14.0	1 58.8 E	....	....	12.0,13.7	.34986	5	....	C IV
			Jul 21, 16	14.5,16.2	1 59.0 E	....	....	14.9,15.9	.34952	5	....	C IV
			Jul 22, 16	8.8,10.6	2 01.1 E	....	....	9.2,10.2	.34956	5	....	C IV
			Jul 24, 16	....	....	10.8 to 17.1 (10)	14 03.2 N	....	....	......	EI 25	C IV
			Jul 25, 16	....	....	11.4 (4)	14 01.8 N	....	....	......	EI 25	C IV
			Jul 25, 16	6.0 to 7.9 (dv)	2 03.5 E	14.0 to 16.3 (8)	14 02.0 N	....	....	25	EI 3	C IV
			Jul 25, 16	9.4	2 02.2 E							
			Jul 26, 16	10.4 to 17.1 (5)	2 00.4 E	....	....	10.7 to 16.8 (8)	.34928	5	....	C IV
			Jul 27, 16	....	....	9.4 to		10.4,11.5	.34952	25	....	C IV
						17.0 (6)	14 03.2 N	14.8,15.6	.34948	25	EI 25	C IV
			Jul 28, 16	....	....	8.8,10.4	14 03.0 N	9.3,10.0	.34970	25	EI 25	C IV
			Jul 28, 16	....	....	10.9,12.3	14 02.6 N	11.4,12.0	.34962	25	EI 25	C IV
			Jul 28, 16	....	....	14.8 (4)	14 03.4 N	....	....	......	EI 3	C IV
			Jul 29, 16	8.9 to 11.7 (dv)	1 58.9 E	....	....	....	....	25	....	C IV
			Jul 31, 16	9.2 to 15.7 (5)	1 58.1 E	....	....	9.5 to 15.3 (8)	.34967	25	....	C IV
			Aug 3, 16	15.9 to 17.9 (dv)	2 01.1 E	....	....	....	....	5	....	C IV

NEW CALEDONIA (INCLUDING LOYALTY ISLANDS).

Station	Latitude	Long. East of Gr.	Date	Declination: Local Mean Time	Declination: Value	Inclination: L. M. T.	Inclination: Value	Hor. Intensity: L. M. T.	Hor. Intensity: Value	Instruments: Mag'r	Instruments: Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Paagoumene	20 29.2 S	164 11	Jan 30, '15	7.7, 9.1	9 11.6 E	10.0	45 25.5 S	8.1, 8.7	.33867	14	14.1256	WCP
Uvea Island	20 38.0 S	166 31	Feb 16, 15	9.4,10.9	9 41.5 E	14.4	45 37.3 S	9.8,10.6	.33468	14	14.1256	WCP
Lifu Island	20 46.8 S	167 09	Feb 14, 15	14.1	9 52.9 E	15.4	45 06.8 S	14.4	.33814	14	14.12	WCP
			Feb 18, 15	14.8	9 50.3 E	....	....	....	....	14	....	WCP

[1] Azimuth from chart.

ISLANDS, PACIFIC OCEAN.

NEW CALEDONIA (INCLUDING LOYALTY ISLANDS)—*Concluded.*

Station	Latitude	Long. East of Gr.	Date	Declination: Local Mean Time	Declination: Value	Inclination: L. M. T.	Inclination: Value	Hor. Intensity: L. M. T.	Hor. Intensity: Value	Instruments: Mag'r	Instruments: Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Lifu Island, *Secondary*	20 46.8 S	167 09	Aug 3, '15	13.3 to								
			Aug 4, 15	13.3 (dv)	9 47.9 E					14		WCP
Maré Island	21 32.6 S	167 53	Feb 19, 15	8.9, 10.1	9 25.0 E	14.4	46 44.3 S	9.2, 9.8	.32894	14	14.125	WCP
Bourail	21 37.0 S	165 29	Jan 27, 15	15.8	9 53.7 E	16.7	46 25.0 S	16.1	.33596	14	14.12	WCP
Noumea	22 16.3 S	166 28	Jan 26, 15	9.3, 10.7	10 20.6 E	14.4	47 00.0 S	9.7, 10.4	.33448	14	14.1256	WCP
Walpole Island	22 37.0 S	168 58	Feb 6, 15	17.0, 17.2	10 11.6 E					14		WCP
			Feb 8, 15			9.0	47 31.4 S	10.2, 10.9	.32682	14	14.1256	WCP

NEW GUINEA (INCLUDING LOUISIADE AND D'ENTRECASTEAUX ISLANDS).

Station	Latitude	Long. East of Gr.	Date	Declination: Local Mean Time	Declination: Value	Inclination: L. M. T.	Inclination: Value	Hor. Intensity: L. M. T.	Hor. Intensity: Value	Instruments: Mag'r	Instruments: Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Mambare	8 04.3 S	148 01	Nov 29, '15	17.2	5 19.5 E			17.5	.36548	14		WCP
Kiriwina Island	8 31.8 S	151 00	Nov 28, 15			9.8	28 33.0 S	10.4	.36500	14	14.12	WCP
Buna Bay	8 40.3 S	148 25	Nov 30, 15	13.7, 14.9	5 38.9 E	12.0	29 16.1 S	14.0, 14.6	.36760	14	14.1256	WCP
Yule Island, *B*	8 49.8 S	146 33	Nov 16, 15	16.9	5 35.8 E	17.8	29 46.2 S	17.2	.36950	14	14.12	WCP
Yule Island, *A*	8 50.0 S	146 33	Nov 1, 15	9.7	5 27.8 E					14		WCP
Gawa Island	8 59.6 S	152 10	Nov 27, 15			18.9	28 57.7 S	18.2	.36402	14	14.12	WCP
Cape Nelson	9 03.3 S	149 17	Dec 1, 15	7.0	6 36.7 E	7.6	29 18.2 S	6.7	.36991	14	14.1	WCP
Daru Island	9 05 S	143 11	Nov 15, 15			9.2	30 34.2 S	8.6	.37018	14	14.12	WCP
Woodlark Island	9 09.2 S	152 44	Oct 27, 15	15.0, 16.3	6 25.8 E			15.3, 16.0	.36453	14		WCP
			Oct 28, 15			11.3	29 29.1 S				14.1256	WCP
Entrance Island	9 12.1 S	152 25	Nov 27, 15	9.5	6 36.9 E	11.1	29 25.8 S	9.9	.36439	14	14.12	WCP
Port Moresby, *B*	9 28.1 S	147 09	Nov 4, 15	12.2, 14.5	5 44.0 E	15.0	30 40.4 S	12.6, 14.1	.36905	14	14.12	WCP
Port Moresby, *A*	9 29.1 S	147 09	Oct 23, 15	11.1	5 41.3 E			11.4	.36871	14		WCP
			Nov 3, 15			16.9	30 37.6 S				14.1256	WCP
Ipoteto Island	9 38.0 S	150 01	Dec 1, 15			16.5	31 26.9 S				14.12	WCP
Kapakapa	9 50.0 S	147 31	Nov 18, 15			12.0	31 21.7 S	11.3	.36694	14	14.12	WCP
Kiagouam Island	10 22.4 S	151 25	Nov 25, 15	7.3	6 15.1 E	11.3	31 44.7 S	10.4	.36741	14	14.12	WCP
Delami Island	10 31.0 S	149 48	Nov 20, 15	9.1	5 58.1 E			9.4	.36435	14		WCP
Samarai, *B**	10 36.7 S	150 40	Dec 6, 15	6.0	9 06.1 E	7.3	32 34.6 S	6.4	.37650	14	14.12	WCP
Samarai, *A**	10 36.8 S	150 40	Oct 25, 15	14.3, 15.7	8 39.8 E			14.6, 15.3	.38088	14		WCP
			Oct 26, 15			10.6	33 01.6 S				14.1256	WCP
			Dec 2, 15	16.7	8 37.3 E					14		WCP
Kwato Island*	10 37.0 S	150 38	Dec 3, 15	12.8, 14.5	4 53.8 E	16.2	32 29.9 S	13.4, 14.2	.36805	14	14.1256	WCP
Misima Island	10 41.2 S	152 50	Nov 22, 15	20.8	6 40.1 E					14		WCP
			Nov 23, 15	7.2	6 37.6 E	6.4	31 54.4 S	5.6	.36596	14	14.12	WCP
Suau Harbor*	10 41.4 S	150 15	Nov 20, 15	16.0	5 15.9 E	16.9	31 46.0 S	16.2	.36680	14	14.12	WCP
Doini Island	10 41.6 S	150 43	Nov 24, 15	4.4	6 13.4 E					14		WCP
Panasesa Island	10 44.0 S	151 42	Nov 23, 15	17.5	6 16.7 E			17.8	.36449	14		WCP

NEW HEBRIDES.

Station	Latitude	Long. East of Gr.	Date	Declination: Local Mean Time	Declination: Value	Inclination: L. M. T.	Inclination: Value	Hor. Intensity: L. M. T.	Hor. Intensity: Value	Instruments: Mag'r	Instruments: Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Kakea Island	13 50.3 S	167 36	Mar 3, '15	8.3	9 15.3 E	8.0	34 45.5 S	7.2	.35161	14	14.12	WCP
Aoba Island	15 23.0 S	167 44	Feb 28, 15	10.9, 12.6	10 21.6 E	14.9	36 05.9 S	11.2, 11.8	.35544	14	14.1256	WCP
Tangice Island	15 35.2 S	167 01	Feb 26, 15	16.6	8 55.4 E					14		WCP
Tangoa Island	15 35.3 S	166 59	Mar 5, 15					12.0	.35322	14		WCP
Tasariki	15 37.4 S	166 47	Mar 5, 15	16.4	8 59.6 E	16.8	36 44.5 S			14	14.12	WCP
Pentecost Island	15 51.3 S	168 10	Mar 7, 15	16.4	8 48.4 E	17.0	36 55.7 S			14	14.25	WCP
Tesman Bay	16 17.0 S	167 40	Mar 8, 15	15.4	9 02.6 E			15.7	.35149	14		WCP
Port Sandwich	16 25.6 S	167 44	Feb 24, 15			15.8	38 28.1 S	14.9	.35203	14	14.12	WCP
Ngala	16 41.2 S	168 17	Mar 10, 15	15.6	8 37.0 E			16.6	.35005	14		WCP
Diamond Bay	16 47.2 S	168 10	Feb 23, 15			13.7	38 00.1 S				14.1256	WCP
Fila	17 44.3 S	168 19	Mar 13, 15	15.8	9 31.6 E	16.8	40 11.6 S	16.1	.34879	14	14.12	WCP

NORFOLK ISLAND.

Station	Latitude	Long. East of Gr.	Date	Declination: Local Mean Time	Declination: Value	Inclination: L. M. T.	Inclination: Value	Hor. Intensity: L. M. T.	Hor. Intensity: Value	Instruments: Mag'r	Instruments: Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Norfolk Island	29 01.7 S	167 58	Mar 18, '15	11.8, 13.6	11 55.2 E	14.7	55 15.3 S	12.6, 13.2	.29878	14	14.125	WCP

* Local disturbance.

ISLANDS, PACIFIC OCEAN.

SAMOAN ISLANDS.

Station	Latitude	Long. East of Gr.	Date	Declination: Local Mean Time	Declination: Value	Inclination: L. M. T.	Inclination: Value	Hor. Intensity: L. M. T.	Hor. Intensity: Value	Instruments: Mag'r	Instruments: Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Apia, Samoa Observatory, *N*	13 48.4 S	188 14	May 17, '15	17.4	9 53.6 E	16.5	29 50.2 S	14.7,15.4	.35388	14	14.1256	WCP
			May 19, 15	14.9	9 53.4 E	....	....	....	....	14	....	WCP
			May 20, 15	....	....	12.5	29 51.8 S	10.6,11.2	.35401	14	14.1256	WCP
Apia, Samoa Observatory, *West Pier*	13 48.4 S	188 14	May 17, 15	9.8,11.1	9 51.4 E	12.1	29 52.0 S	10.2,10.8	.35353	14	14.1256	WCP
			May 19, 15	15.9	9 52.7 E	....	....	....	....	14	....	WCP
Pago Pago*	14 16.8 S	189 20	Jun 12, 16	....	....	15.1 (3)	29 46.4 S	....	....	......	EI 25	C IV
			Jun 13, 16	10.3,12.3	9 27.8 E	....	....	10.8,11.9	.35670	25	....	C IV
			Jun 16, 16	10.8,11.1	9 28.6 E	....	....	....	....	25	....	C IV

SOCIETY ISLANDS.

Station	Latitude	Long. East of Gr.	Date	Declination: Local Mean Time	Declination: Value	Inclination: L. M. T.	Inclination: Value	Hor. Intensity: L. M. T.	Hor. Intensity: Value	Instruments: Mag'r	Instruments: Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Point Fareute*	17 31.5 S	210 26	Jun 7, '16	9.6 to 14.9 (4)	9 56.4 E	13.9	31 12.4 S	10.1,10.7	.32519	14	14.1256	HFJ
			Dec 27, 20	11.5,11.7	10 11.3 E	13.0,14.1	30 58.0 S	13.4,14.7	.32436	25	EI 25	C VI
			Dec 27, 20	....	....	15.1	30 59.1 S	....	....	......	EI 25	C VI
Papeete*	17 31.8 S	210 27	Jun 9, 16	9.4 to 14.2 (4)	8 24.5 E	13.2	30 09.6 S	9.7,10.5	.33428	14	14.1256	HFJ
Small Coral Island (Papeete Harbor)*	17 32.0 S	210 25	Jun 10, 16	9.5 to 14.4 (4)	10 09.5 E	13.5	29 45.1 S	9.9,10.4	.33750	14	14.1256	HFJ
Fort Taravao*	17 43.0 S	210 42	Jun 17, 16	9.4,10.6	9 29.8 E	13.3	30 40.7 S	9.8,10.3	.34839	14	14.1256	HFJ
Vieno's Farm*	17 43.4 S	210 41	Jun 23, 16	9.4,10.7	10 56.2 E	13.1	31 24.7 S	9.8,10.4	.34500	14	14.1256	HFJ
Poroi's Farm*	17 44.2 S	210 42	Jun 25, 16	9.4,10.9	10 05.6 E	12.6	32 17.7 S	9.9,10.6	.34138	14	14.12	HFJ
Pururu, *B*	17 47.2 S	210 37	Jun 15, 16	8.7,11.5	9 52.2 E	....	....	....	....	14	....	HFJ
Pururu, *A*	17 47.3 S	210 37	Jun 15, 16	9.8,11.0	9 38.2 E	13.1	30 41.6 S	10.3,10.8	.33945	14	14.1256	HFJ
Mapeti, *B*	17 47.4 S	210 36	Jun 13, 16	8.6,11.6	9 50.5 E	....	....	....	....	14	....	HFJ
Mapeti, *A*	17 47.5 S	210 36	Jun 13, 16	9.8,11.3	9 49.5 E	13.2	31 20.6 S	10.3,11.0	.33932	14	14.1256	HFJ

SOLOMON ISLANDS.

Station	Latitude	Long. East of Gr.	Date	Declination: Local Mean Time	Declination: Value	Inclination: L. M. T.	Inclination: Value	Hor. Intensity: L. M. T.	Hor. Intensity: Value	Instruments: Mag'r	Instruments: Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Faisi Island	7 04.5 S	155 53	Sep 16, '15	10.1,11.6	7 59.6 E	....	....	10.5,11.3	.36894	14	....	WCP
			Sep 16, 15 / Sep 17, 15	13.6 to 11.0 (dv)	6 57.4 E	11.6	24 40.4 S	....	....	14	14.1256	WCP
Salicana Island	7 26.6 S	157 40	Sep 20, 15	10.0,11.3	7 06.0 E	12.4,14.6	25 02.4 S	10.4,11.0	.36524	14	14.1256	WCP
Binskin's Station	7 46 S	156 34	Sep 18, 15	....	....	11.5	26 11.4 S	10.0,10.6	.36680	14	14.1256	WCP
Gizo, *A*	8 06.0 S	156 51	Sep 15, 15	7.5	7 04.6 E	....	....	9.4,10.0	.36786	14	....	WCP
Gizo, *B*	8 06.0 S	156 51	Sep 19, 15	15.8	7 03.5 E	16.1	26 13.6 S	....	....	14	14.12	WCP
Simbo Island	8 16.7 S	156 32	Sep 19, 15	7.4	7 40.8 E	....	....	....	....	14	....	WCP
Warata Island	8 30.2 S	158 03	Sep 21, 15	....	....	....	....	9.4	.36625	14	....	WCP
Makambo Island	9 04.9 S	160 12	Sep 10, 15	....	....	11.8	27 24.8 S	....	....	......	14.1256	WCP
			Sep 23, 15	9.4,11.0	7 42.0 E	....	....	9.8,10.7	.36677	14	....	WCP
Tulagi	9 06.6 S	160 11	Sep 10, 15	16.0	7 48.3 E	....	....	....	....	14	....	WCP
			Sep 11, 15	10.7,12.8	7 46.2 E	15.8	26 59.6 S	11.3,12.5	.36706	14	14.1256	WCP
Guadalcanar Island	9 25.2 S	160 17	Sep 13, 15	....	....	....	....	15.8	.36635	14	....	WCP
			Sep 24, 15	14.8	7 38.9 E	14.4	27 49.0 S	....	....	14	14.12	WCP
Kumbara Island	9 31.0 S	160 33	Sep 13, 15	7.9	7 33.4 E	8.2	28 16.0 S	7.3	.36651	14	14.12	WCP

TOKELAU ISLANDS.

Station	Latitude	Long. East of Gr.	Date	Declination: Local Mean Time	Declination: Value	Inclination: L. M. T.	Inclination: Value	Hor. Intensity: L. M. T.	Hor. Intensity: Value	Instruments: Mag'r	Instruments: Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Atafu Island	8 32.4 S	187 29	May 27, '15	9.6,15.7	8 53.9 E	14.9	18 20.8 S	10.2,10.8	.35473	14	14.1256	WCP
Fakaofu Island	9 23.0 S	188 45	Jul 19, 15	13.4	9 47 E	13.0	20 12.0 S	12.5	.35394	14	14.2	WCP
Swains Island	11 03.3 S	188 55	May 25, 15	13.7,15.1	8 47.4 E	15.6	25 39.0 S	14.1,14.8	.34138	14	14.12	WCP

TONGA ISLANDS.

Station	Latitude	Long. East of Gr.	Date	Declination: Local Mean Time	Declination: Value	Inclination: L. M. T.	Inclination: Value	Hor. Intensity: L. M. T.	Hor. Intensity: Value	Instruments: Mag'r	Instruments: Dip Circle	Obs'r
	° ′	° ′		h h h	° ′	h h	° ′	h h	c. g. s.			
Neiafu	18 39.0 S	186 01	May 11, '15	14.3,15.6	10 30.2 E	17.2	37 49.6 S	14.7,15.3	.34337	14	14.1256	WCP
Lifuka	19 48.6 S	185 39	May 10, 15	16.6	11 09.5 E	17.1	39 42.0 S	....	....	14	14.12	WCP
Nukualofa	21 08.1 S	184 48	May 9, 15	13.7,15.0	11 03.4 E	16.3	41 35.5 S	14.0,14.7	.33762	14	14.12	WCP

* Local disturbance.

OBSERVERS' FIELD REPORTS.

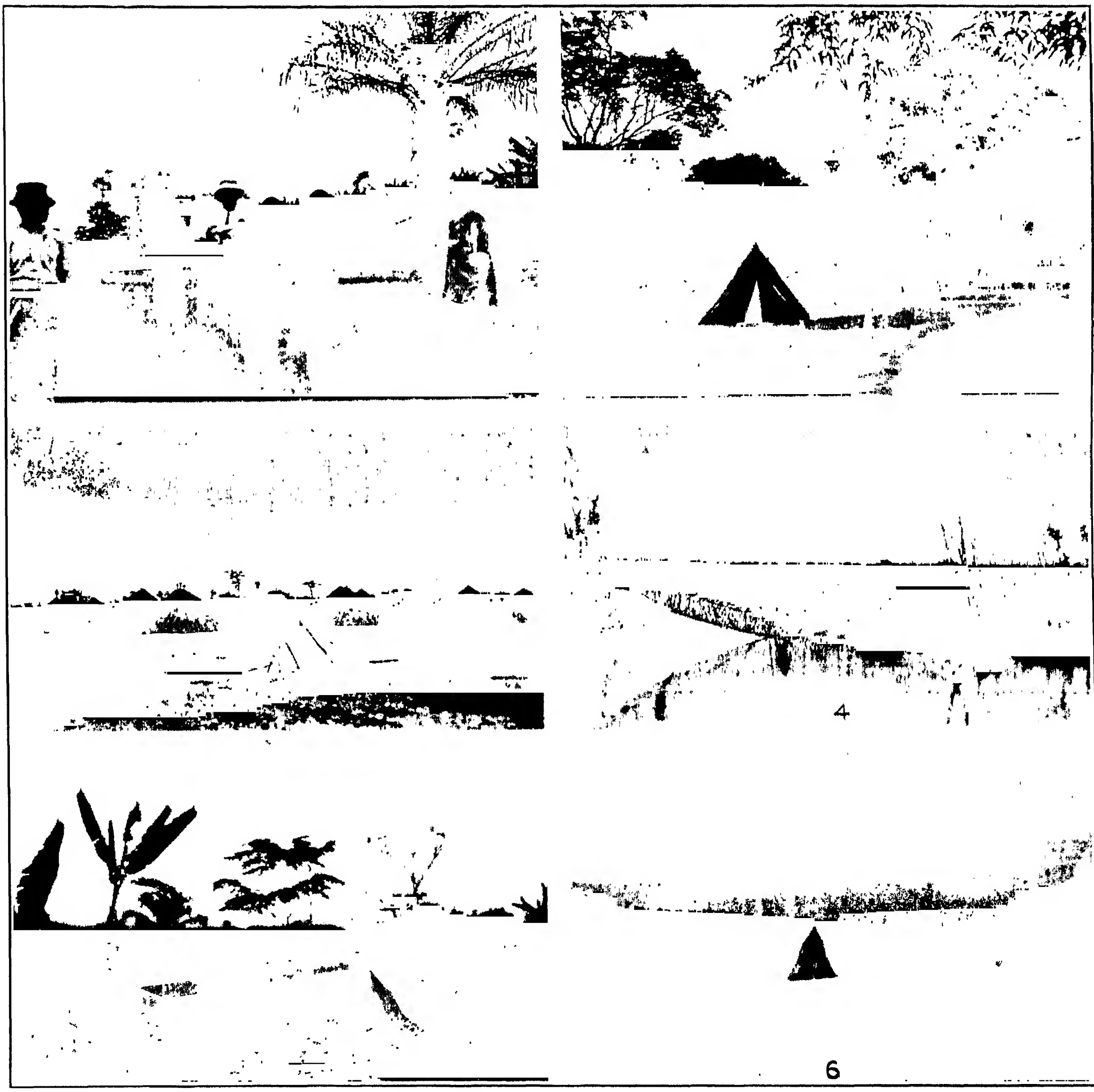
The following reports, or extracts, will give some idea of the conditions under which the various magnetic surveys and magnetic exploratory expeditions, conducted during the period 1914–1920, have been accomplished. The world-wide scope of the operations, as shown by the Summary (Table 6, p. 24), is further indicated by these reports. The latter not infrequently contain information only of special concern to the Department of Terrestrial Magnetism, and so they are not always given in full as submitted by the observers. As the observers write the reports themselves, their own particular achievements are necessarily minimized. It is hoped that sufficient has been retained under each observer's report to enable the reader to judge of the care, skill, courage, and thoroughness with which the work was executed. The reports will be found to contain matter of geographic interest and useful information for future explorers; they are arranged alphabetically by observers' names.

Each of the reports contains a table listing the names of the stations occupied, together with dates of occupation and adopted latitudes and longitudes. Detailed particulars describing the stations will be found in the section of this Volume entitled "Descriptions of Stations" (pp. 223 to 348), where the arrangement is alphabetical according to country. The magnetic data are given in the Table of Results (pp. 30 to 97), where the arrangement of the stations under any particular country is according to latitude. The localities at which observations had been previously made by observers of the Department are printed in italics in the tables accompanying the following reports. Typical views taken during the progress of the various expeditions are given in Plates 1 and 3 to 7.

D. W. Berky, on Magnetic Work Along the Araguaya and Tocantins Rivers in Brazil, March to September 1915.

In accordance with instructions of March 2 and 3, 1915, I left Washington, D. C., March 5, and sailed from New York March 6 on the Lamport and Holt Line steamship *Byron*. The following instrumental outfit was carried: universal magnetometer No. 19 with dip needles Nos. 2 and 6 of this instrument and Nos. 1 and 2 of No. 21, 2 pocket chronometers, 3 watches, observing tent and accessories.

Upon arrival at Rio de Janeiro March 23, I called on Dr. Henrique Morize, in charge of the Brazilian National Observatory, to consult with him regarding the proposed work. Dr. Morize took a deep interest in the expedition, gathered valuable information concerning the routes, and arranged for intercomparison of universal magnetometer No. 19 with the Brazilian standards at the Magnetic and Meteorologic Observatory at Vassouras. These comparisons were made between March 26 and April 1, and on the 3d of April one of the stations established in 1910 by the *Carnegie* was reoccupied. Preparations having been completed at Rio de Janeiro, travel was resumed on April 8 via São Paulo toward the northernmost rail terminus of southern Brazil. A station was occupied at Araguary April 15, and on April 17 another was occupied at Catalão, the last



Typical Views of Magnetic Expeditions in Africa.

1. Transportation, Cameroun.
2. Huambo, Angola.
3. Mangal, Cameroun.
4. Hanging bridge, French Equatorial Africa.
5. Eseka, Cameroun.
6. Waldea, Abyssinia.

railway point of the itinerary. The following day I started for Goyaz City with pack animals. The 320 miles from Catalao were covered by May 4.

After an examination of all available information regarding routes, it seemed best to proceed first by pack animals to Leopoldina on the Araguaya River, thence down this river to Conceicão, a town not shown on the maps, thence westward overland to the Rio Fresco, an uncharted branch of the Xingu, and finally to follow these waters to the Amazon. The journey started May 18, and Leopoldina, on the Araguaya, was reached by pack animals May 25.

Finding that the Araguaya could be ascended readily as far as the little town of Registro do Araguaya, I decided to make this trip in the hope of finding some route to the upper Xingu, which would be practicable with the time and means at my disposal, as my instructions particularly mentioned this route. Accordingly, I started up the river in a small boat, with a crew of 3 men, and arrived at Registro June 8. As no satisfactory information could be obtained regarding routes to the headwaters of the Xingu, we returned to Leopoldina and arrived June 12. On June 14 the descent was resumed, and Conceicão was reached July 8. Here it was found that a route to the Rio Fresco and Xingu was feasible, although expensive. However, I considered it inadvisable under the circumstances, and, therefore, accepted an offer to accompany a rubber trader who was on the point of leaving for Para (Belem) by way of the Araguaya in a well-manned barge.

On July 11 the descent of the Araguaya was continued. The boatmen proved expert, as the first of a numerous series of rapids was encountered on July 14. From July 14 to August 18 we had many interesting experiences, grounding in shoal places, shooting numerous rapids of all sizes and degrees of difficulty and danger, and making portages. (See view 4 of Plate 6.)

On August 18 we arrived at Alcobaça where there is steamer communication with Para. Accordingly, travel was resumed by river steamer on August 22, and Para was reached August 30. With the reoccupation of our magnetic station at Pinheiro, near Para, the work was concluded. On September 4, I sailed for New York, arriving at Washington September 22, 1915.

The time consumed in carrying out this work was 200 days (March 6 to September 22, 1915). Excluding travel to and from Washington, 169 days were spent in the field, so that an average of 4.1 days was required for a station, but if the intercomparisons at Vassouras are omitted and field time counted from the first campaign station at Araguary, then the average time per station is 3.7 days. The only delay experienced was due to the numerous rapids in the lower course of the Araguaya and Tocantins. The Itaboca series in the Tocantins alone consumed ten days. Travel to and from the field amounted to about 8,050 miles, travel in the field to about 2,550 miles, of which 725 were by rail, 450 by pack animals and about 1,375 by river. About 200 miles of the river travel were covered by steamboat. The average total travel per station was 258.5 miles, and the average field travel was 62.2 miles per station.

It is a great pleasure to make acknowledgment here of the courtesies and assistance extended by Dr. Henrique Morize, director of the National Observatory of Brazil; by Mr. Gottschalk, the American consul at Rio de Janeiro; by Mr. Horace E. Williams of the Brazilian Geologic Service; by Mr. Frederick Glass, English missionary at Goyaz City; and by Frei Sebastião M. Thomas of Uberaba, Inspector of Dominican Missions.

The course of the Araguaya between Registro and Leopoldina is represented by dotted line on the Mappa Geral do Brazil of 1913, and Stieler's Atlas. The whole part south of the Rio das Mortes appeared as Rio Araguaya or Grande on Stanford's map, which contained less detailed information than either of the other two. Since many of the latitudes from these maps differ from our observed latitudes, it is probable that the map-longitudes are also uncertain.

The following table shows the magnetic stations and the order in which they were occupied; for the values of the magnetic elements, see Table of Results.

TABLE 8.

No.	Name	Date	Lat. South	Long. East
		1915	° ′	° ′
1	Vassouras, Rio de Janeiro	Mar. 26	22 24.0	316 21
2	Rio de Janeiro, *B*, Rio de Janeiro	Apr. 2	22 58.7	316 49
3	Araguary, Minas Geraes	" 14–15	18 39.0	311 49
4	Catalão, Goyaz	" 17	18 10.8	312 07
5	Fazenda Cachoeira, Goyaz	" 20	17 45.7	311 54
6	Santa Cruz, Goyaz	" 23	17 19.5	311 34
7	Bella Vista, Goyaz	" 26	16 59.4	311 05
8	Campinas, Goyaz	" 29	16 40.8	310 43
9	Curralinho, Goyaz	May 3	16 02.0	310 12
10	Goyaz, Goyaz	" 13–14	15 56.6	309 52
11	Rio Terreiro, Goyaz	" 21	15 35.8	309 25
12	Leopoldina, Goyaz	" 27–28	14 55.0	308 56
13	Barreira Branca, Goyaz	June 1–2	15 02.0	308 43
14	Barreira Canta Gallo, Matto Grosso	" 3–4	15 05.3	308 28
15	Barreira do Padre, Matto Grosso	" 5–6	15 21.7	308 22
16	Registro, Matto Grosso	" 8–9	15 44.8	308 13
17	Canga Island, Goyaz	" 15–16	14 36.3	309 03
18	Melancia Island, Goyaz	" 17–18	14 01.7	309 09
19	Café Island, Goyaz	" 19–20	13 28.8	309 19
20	Bocca do Foro Island, Goyaz	" 21–22	12 54.3	309 30
21	Lago Barreira do Viado, Goyaz	" 23–24	12 30.6	309 22
22	Araguaya River 11, Matto Grosso	" 25–26	11 56.6	309 22
23	Rio das Mortes, Matto Grosso	" 26	11 45.8	309 18
24	Fontura's Village, Matto Grosso	" 27–28	11 23.9	309 18
25	Tapirape River, Goyaz	" 29–30	10 39.6	309 24
26	Praia Joachim Alvez, Matto Grosso	July 1–2	10 06.0	309 37
27	Barreira Quicaca, Goyaz	" 3–4	9 26.6	309 54
28	Santa Maria Nova, Goyaz	" 6	8 48.3	310 25
29	Conceicão, Para	" 8–10	8 15.5	310 43
30	Jacusão Rapids, Para	" 14–15	7 43.5	310 42
31	Praia do Cigano, Para	" 17–18	7 27.5	310 38
32	Praia Flor do Calcho, Para	" 20–21	6 48.3	310 55
33	São Miguel Rapids, Para	" 23–24	6 20.2	311 28
34	Grande Rapids, Para	" 26–27	6 08.2	311 35
35	Espinhel, Para	" 29–30	5 33.5	311 42
36	Maraba, Para	Aug. 2	5 20.9	310 49
37	Itaboca, Para	" 8	4 28.9	310 27
38	Alcobaça, Para	" 19–20	3 45.6	310 19
39	São Joachim, Para	" 23	3 02.2	310 20
40	Cameta, Para	" 28–29	2 15.2	310 30
41	Pinheiro, Para	Sept. 3–4	1 17.9	311 31

Conceicão (8° 15.5′ S; 49° 17′ W), a town of about 5,500 inhabitants, and Maraba (5° 20.9′ S; 49° 11′ W), a town of about the same size at the mouth of the Rio Itacaiuna, were not shown on the above mentioned maps. This apparent lack of information is probably the result of the inaccessibility of this region, which is increased by the numerous rapids in the lower course of the Araguaya and upper course of the Tocantins.

F. BROWN, ON MAGNETIC WORK IN NORTHERN TERRITORY, AUSTRALIA, MARCH TO OCTOBER 1914.

During March 1914, in accordance with arrangements made by my chief of party, Mr. E. Kidson, I left Adelaide, South Australia, for an expedition around the north coast of Northern Territory, taking magnetometer No. 17, and dip circle No. 172. I sailed from Sydney on March 20, and arrived at Darwin April 4, having reoccupied en route the magnetic stations of 1913 at Brisbane and Rockhampton in Queensland.

The conditions of travel in the regions to be reached were such that they could best be covered by a series of minor expeditions from Darwin, the only place of importance

along that part of the coast, as a base. The work of the expedition may then be divided and each portion treated separately under the following heads:

I. Victoria River by steamer and return overland.
II. Bathurst and Melville islands by lugger.
III. West coast of Gulf of Carpentaria by steamer.
IV. East Alligator River by government boat.
V. Cape Wessel and north coast points by open launch.

I. At Darwin I learned that the government coastal steamer *Leichhardt* was leaving at once for Victoria River, and I availed myself of the opportunity to reach that section. We arrived at Depot, a store on the river about 90 miles inland, on April 12, after a delay caused by the steamer going aground, which gave me the opportunity of making a station 50 miles from the mouth of the river. Fearing that the *Leichhardt* would now miss the spring tides and thus be detained in the river, and finding that the packhorse mail was about to start for Katherine River, I arranged to leave by the overland route. As this was the first trip of the mail by this route, there were no tracks to follow through the very rough country as far as Delamere. The journey was not unpleassant, notwithstanding the season; the water was good, as billabongs and lagoons were found at frequent intervals; and no blacks were seen, though a constant lookout was maintained and firearms were kept at hand, especially at night. The only annoyance of consequence was from the tall spear grass whose sharp penetrating seeds were very irritating. Katherine River was reached April 24, and the station of 1912 was reoccupied. The return to Darwin was by coach to Pine Creek, where another 1912 station was reoccupied, and thence by rail, arriving May 1, after a round trip of about 800 miles.

II. At Darwin I learned that the *Leichhardt* was aground in the Victoria River, with no certainty as to when she might return. I therefore chartered a lugger for a short trip to Bathurst and Melville Islands, taking with me the Malay captain and a crew consisting of another Malay and a Filipino. These men proved to be quiet, reliable, and good sailors. I arrived at Mission Station, Bathurst Island, on May 4, after a rough passage. Then having established the station, we set sail for Cape Van Diemen at the north end of Apsley Straits, and the following day landed about 1 mile from Piper Head, the nearest the captain dared approach Cape Van Diemen on account of the treacherous character of of the sand bars and reefs in the neighborhood. The magnetic station was made near the remains of an old trepang camp. The party was armed in anticipation of trouble, but no blacks were seen. During my work ashore the men collected a supply of turtle eggs and caught plenty of small fish with a net. In the afternoon we put off for Brenton Bay on the north coast of Melville Island, about 70 miles to the eastward, but the next morning while rounding Cape Van Diemen very bad weather came on. The captain thought it dangerous to proceed, and I reluctantly ran back into the straits for shelter as there is no anchorage along that part of the north coast of the island. The weather continued bad the next day, and as it was important that I reach Darwin in time to sail for Boroloola with the *Leichhardt*, the time of whose return from Victoria River was uncertain, we decided to abandon the trip around the island and return at once to Darwin. We accordingly set sail and arrived at Darwin on the morning of May 11, after a trip of 8 days, establishing 3 stations.

III. Making use of a further opportunity while waiting for the delayed government boat, I reoccupied the 1912 station at Batchelor on May 14. Meanwhile the *Leichhardt* had arrived, and the start was made for Boroloola on May 17. When about 90 miles out the vessel began leaking badly, and as the water gained considerably, though all the pumps were kept going, we turned about for Darwin with all boats provisioned and preparations made to abandon ship if necessary. Fortunately, we reached Darwin safely though a large amount of sugar, rice, and flour was ruined by the water. After a delay of

5 days for repairs, we again set out, and reached Roper River in the Gulf of Carpentaria on June 7. (See view 2 of Plate 4.) The vessel is a ketch of 80 tons, fitted with auxiliary engines, which, however, were not powerful enough for the strong head winds from the south and east which were encountered, sometimes for days together. During these winds, whole days were spent sweltering, but permission was refused me to go ashore for observations, though I asked it whenever we anchored for the day. Night traveling is out of the question, as there are no lights along this entire coast and the seas are full of reefs and shoals. After observations at the Roper River Mission Station, I continued the journey to Boroloola, arriving June 13 after an all-night ride by launch up the McArthur River. There was no boat available here by which to reach points on the Sir Edward Pellew Islands as had been hoped, and I contented myself with a short buckboard trip to Ryan's Bend. I was prevented from going farther afield by the uncertainty of the water supply, and the necessity of being on hand to sail with the *Leichhardt*. On the return voyage, while the vessel was anchored near one of the Sir Edward Pellew Islands for making repairs on the engines, I was permitted to go ashore and make some observations, after which we continued to Darwin, arriving June 29, after an uneventful voyage.

Five weeks were consumed in making the trip. The weather was cool, and on the days when the southeasters were blowing it was uncomfortably cold. The vessel had no passenger accommodations. I slept on deck on some water tanks, using my own rug and towels throughout the whole trip; the food, however, was good. Few blacks were seen, though several times canoes came to us to trade pearl and turtle shell for tobacco and beads. The coast is generally low and sandy, though some of the islands have an essentially tropical appearance.

IV. The Administrator at Darwin arranged for the *Lone Hand*, a government lugger, to take me to the East Alligator River. After various delays, one of which enabled me to make observations at Cape Hotham, we finally arrived at the landing on East Alligator on July 24, and I immediately occupied a magnetic station nearby. A fierce bush-fire, however, caused me to vacate the station in the afternoon, and I had a very narrow escape from being caught and having the tent and instruments burned completely. A black who had been stationed to watch the fire assured me that it had not jumped the intervening creek, so I went on with the observations. Some sparks brought by a sudden shift of the wind started a fire within about 200 yards of the tent, which a crowd of blacks hurriedly gathered for the purpose were unable to check. There was no time for starting a back fire. I began hurriedly dismounting the magnetometer, when the blacks lost their heads and let the tent down on me. The pole in falling struck the instrument and caused rather serious damage, but I was able to make temporary field repairs sufficient to enable me to proceed with the work of my expedition. After making observations at Oenpelli, which I reached by pack-horses kindly provided by Mr. Cahill, I returned in the *Lone Hand* to Darwin. A month had been taken for this short trip, but I had no means of shortening the time. The boat was an 8-ton lugger, loaded with cargo and stores, and had no accommodations even for one passenger. I slept in the scuppers at night, assisted with the sails and in steering during the day, and managed to keep in good health and spirits, notwithstanding the exasperating delays. Mosquitoes and sand flies were very bad except at sea. The river and creek were full of large alligators, which afforded good shooting. Food ran short during one stage of the journey, when we lived on blackfellow's tea, damper, and jam.

V. The government boats could serve me no further, so I chartered the *Don*, a small, 2-ton, 35-foot open launch, for my trip to Cape Wessel and other points along that coast. I set out on Thursday, August 6, with a party consisting of myself, a Chinese engineer, and a Filipino sailor. At sundown Sunday evening we reached Victoria at the old military settlement of Port Essington. We called at a trepang camp for water, hoping

to obtain a blackfellow to act as guide round the coast, but in this we were unsuccessful. After making observations we set our course for Cape Croker. Head winds and rough seas delayed us, so that it was Wednesday afternoon when we dropped anchor in a sheltered position on the west side of the cape. Resuming our voyage, we reached the Aboriginal Settlement at Bowen Straits on Friday, August 14, and handed Mr. Murphy, the Protector, the Administrator's instructions, directing him to accompany me in case of trouble with the natives, who have a bad reputation on parts of the coast. He accordingly came aboard with two of his "boys," one of whom was a boat boy and knew the coast as far as King River. Our course lay eastward, and De Courcy Head was rounded after a hard fight against wind and sea; but when the tide changed, we were swept back and forced to shelter under Cape Cockburn for a day, during which I occupied a station ashore. De Courcy Head is considered the worst place on the whole north coast, there being no shelter between it and the Goulburn Islands; at times the *Leichhardt* and other coastal vessels have been forced to shelter for a week or more before the weather would permit them to round De Courcy Head. Luckily, the wind dropped a little, and by making an early start we succeeded in reaching the Goulburn Islands late Tuesday night. After calling at a trepang camp the next morning for water, we proceeded about 20 miles up the King River to an old landing where a station was established.

From this point eastward, the natives are of doubtful friendliness, so Mr. Murphy and one of his boys always accompanied me ashore and maintained a watch during my stay. A fair run was made to Liverpool River, but on the way to Glyde River strong currents in Boucaut Bay held us back, and we anchored under a small island off Cape Stewart. The mouth of the Glyde is very shallow, and failing to find the channel we went on to the Goyder River and I made my station at an old landing not shown on the chart. Being short of water, we went on into the river as far as possible in search of a waterhole, but failed to find even a place to land on account of the jungle lining the banks. Returning, we made an unsuccessful search at a deserted camp at Banyan Island, and then left for Cadell Straits, hoping to meet natives who might lead us to water. On entering the west end of the straits, Mr. Murphy's boy remembered a waterhole he had visited on a previous occasion, and guided us to a beautiful spring where we filled every available tin. About halfway through the straits, we met two canoes full of fairly wild blacks. I took one who could speak a little English to act as pilot. Our party now numbered 7, and we were crowded for sleeping space. Continuing along the west side of Wessel Island, we found a snug anchorage on the west side of the cape on Sunday, August 30. We were now 24 days out and had covered more than 750 miles against strong head winds and rough seas. Returning by way of Cunningham Isles and Cape Wilberforce we crossed to Inglis Island in bad weather and shipped some nasty seas during a squall in the afternoon. At Cape Wilberforce we found conditions outside so bad that it was dangerous to undertake the proposed trip to Cape Arnhem in our little open boat, and we therefore crossed to the most southern of the Bromby's Islands, where observations were made. On account of the heavy seas running, our anchorage here became unsafe and we were forced to return to Malay Road for shelter. It was on this crossing that we came near disaster. The rudder suddenly jammed and we headed directly on the steep cliffs of Cape Wilberforce. The Chinese engineer lost his head and ran about excitedly, but the blacks kept cool, and our boat boy managed to steer with an oar until we were clear of the cliffs and the danger was passed. The fact that we had our foresail set saved us from being swamped, as it prevented the boat getting broadside on to the waves. Wishing to get observations as far south as possible, we entered a large creek at the southwest corner of Arnhem Bay and ascended it, hoping to find a landing, but, 20 miles in, the creek terminated in a swamp. Our water was now completely exhausted and the waterhole to

which our Elcho Island pilot led us had just been covered by the tide, so we pushed on without delay. He then guided us to the shore of Buckingham Bay, where he found a small spring, and we took on the much-needed supply of water. We then headed for Alger Island and thence to Cadell Straits, where we dropped the pilot at the camp of his tribe, after making him a present of tobacco, matches, and flour for his services. With favoring wind and sea, we made good progress to Mr. Murphy's station at Bowen Straits, which we reached on September 10 with no mishap save the loss of our mainsail, which was torn beyond repair and was useless for the remainder of the trip. Mr. Murphy accepted my invitation to accompany me to Darwin, where we arrived September 16, thus ending a trip of about 1,650 miles in our little launch, which had occupied about 6 weeks.

Table 9 gives list of stations occupied, with dates and geographic positions; for magnetic data, see Table of Results.

TABLE 9.

No.	Name[1]	Date	Lat. South		Long. East	
		1914	°	′	°	′
1	Brisbane	Mar. 23	27	27.0	153	02
2	Rockhampton	" 25	23	22.0	150	30
3	Victoria River	Apr. 8	15	24.5	130	02
4	Depot (Victoria River)	" 13	15	37.0	130	27
5	Timber Creek	" 14	15	38.1	130	29
6	Delamere	" 19	15	44.1	131	32
7	Katherine River	" 25	14	26.1	132	17
8	Pine Creek, *A*	" 28, 29	13	49.6	131	51
9	Pine Creek, *B*	" 29	13	49.6	131	51
10	Mission Station (Bathurst Island)	May 4	11	45.5	130	39
11	Piper Head	" 6	11	16.3	130	23
12	Bynoe	" 9, 10	11	45.3	130	40
13	Batchelor	" 14, 15	13	03.6	131	03
14	Darwin	" 19	12	26.7	130	50
15	Mission Station (Roper River)	June 8	14	44.9	134	50
16	Borroloola	" 13, 14	16	04.2	136	22
17	Ryan's Bend	" 15, 16	16	08.2	136	08
18	Five-Mile Bar (McArthur River)	" 17	16	00.2	136	24
19	Black Rocks	" 22	15	56.4	136	31
20	Sir Edward Pellew Islands	" 23	15	35.1	136	43
21	Cape Hotham	July 16	12	04.0	131	16
22	Cahill's Landing	" 24, 27	12	21.4	132	57
23	Oenpelli	" 25, 26	12	19.8	133	02
24	Connell's Creek	" 31	12	17.4	131	32
25	Victoria (Port Essington)	Aug. 10	11	22.5	132	08
26	Cape Croker	" 12, 13	10	58.4	132	32
27	Cape Cockburn	" 17	11	20.4	132	52
28	Twenty-Mile Landing (King River)	" 19, 20	11	54.7	133	24
29	Cadell's Landing (Liverpool River)	" 22	12	06.3	134	11
30	Goyder River	" 25	12	18.7	135	12
31	Cape Wessel	" 30	11	00.7	136	45
32	Bromby's Islands	Sept. 2	11	51.9	136	34
33	Arnhem Bay	" 4	12	26.6	136	03
34	Alger Island	" 6	11	53.6	135	57
35	Bowen Straits Aboriginal Station	" 10, 11	11	20.6	132	33
36	Brenton Bay	" 13, 14	11	18.4	131	13
37	Point Charles Lighthouse	Oct. 3–7	12	23.4	130	39

[1] Stations 1 and 2 are in Queensland; all the others are in Northern Territory.

Surprisingly few natives had been seen, though signal fires were lighted ahead of us all along the coast. The protector was of the opinion that, being frightened by the size of our party, they were in hiding. We were never visited by hostile canoes during the night, but arms were kept handy at all anchorages east of King River. The sea abounds in reefs and shoals, and a constant watch was maintained for them while under way. Except for short distances known to the blacks, I made myself responsible for the navigation of the

boat, using Admiralty Chart No. 1044 as a guide. I am much indebted to Protector Murphy for his invariable kindness and courtesy, and his assistance went far toward making the trip a successful one. Some of the remote places visited were practically virgin country, and Mr. Murphy has been able to make a valuable report on these little known parts of Northern Territory.

On my arrival at Darwin, I made a short trip to Point Charles Lighthouse, and later took passage on the *West Australian* for Fremantle, terminating my work at Cottesloe, October 26, 1914.

The total time taken for the expedition from leaving Adelaide to arrival at Perth was 225 days. Omitting the two stations in Queensland en route, the field time per station was 5.4 days, and the average field travel per station about 162 miles. This rather high average arises from the necessity of doubling back over the same route in the various short expeditions from Darwin. The average cost per station exclusive of the observer's salary was about $34, which includes the cost of going to and returning from the field.

F. BROWN, ON MAGNETIC WORK IN THE PROVINCES OF HUNAN, KWEICHOW, AND KWANGSI, CHINA, MARCH TO JULY 1915.

According to instructions received from my chief of party, Dr. C. K. Edmunds, dated March 20, 1915, I left Canton with the following outfit: magnetometer No. 9, Dover dip circle No. 177 with dip needles Nos. 1, 2, 5, and 6, two pocket chronometers, one watch, observing tent, pocket compass, boiling-point apparatus with three thermometers, and aneroid barometer.

The route followed from Canton was northward through Kwangtung Province into Hunan, by rail and by launch up the North River to Shiuchow, and thence over several passes to Chenchow located at the head waters of the Lei River in Hunan Province. We then descended the Lei River by small boat (see view 6 of Plate 1) to Hengchowfu, where a caravan was formed with which we traveled westward to Yüanchow Hun. From Yüanchow Hun we went down the Yüan River to Changteh, thence by carriers up the valley of the Ling Kiang to Yungting, and thence in a westerly and southerly direction to Tsunyi and Kweiyang in Kweichow Province. From Kweiyang the overland journey was continued by carriers in southerly and easterly directions to Yiyüan at head of navigation of Lung Kiang in Kwangsi Province. We finally descended the Lung Kiang to Siang in a small boat, from which point Canton was reached by river launches and steamers.

Overland travel was made on foot and by chair, the full caravan consisting of 10 carriers and 6 chair bearers, 3 men to each chair. The roads, though narrow, were generally stone-paved and good. Views 5 and 7 of Plate 1 are typical of country traversed. Poor roads were found in eastern Kweichow and Northern Kwangsi provinces. Continued wet weather caused occasional delays and considerable inconvenience while traveling and observing. Broken bridges and flooded roads held the expedition a few days in Kweichow, and delays by flood occurred on two occasions in upper Kwangsi when boat service was interrupted at Wuchow. In many of the mountainous districts traversed, robbers and bandits were numerous, but local officials always provided an adequate escort of regular soldiers. No hostility was shown by the people, who, however, were usually suspicious and very inquisitive, especially in Hunan Province. Several times the expedition was suspected of being engaged on secret service work, land surveying, and mapping, but no very serious opposition was encountered.

The expedition left Canton on March 23 and returned July 22, 1915, taking a total of 122 days for 31 stations and making the average field time for a station 3.3 days. The

total distance traveled was 2,788 miles, which gives an average of 90 miles to a station. The total cost of trip, exclusive of observer's services, was $526.66, making an average of $17 per station.

The formation of the country is chiefly sandstone, limestone and slates. Coal was seen in several places in Hunan and Kweichow provinces. Iron is mined in the districts round Paoking and in the valley of the Ling Kiang in Hunan. The missionaries of the China Inland Mission, American Presbyterian, Wesleyan, and other missions extended to the party many courtesies, and gave valuable assistance and advice in the hiring of coolies, boats, and other details of travel. Mr. J. C. Parkin, the Kweichow Postal Commissioner of Kweiyang, not only received the party most hospitably, but also gave material assistance in arranging for the latter part of the overland journey. The Chinese officials at Szenan, Tsunyi, and Tuyünfu were especially courteous.

Table 10 gives list of stations occupied with dates and geographic positions; for magnetic data, see Table of Results.

TABLE 10.

No.	Name[1]	Date	Lat. North		Long. East	
		1915	°	′	°	′
1	*Shiuchow*	Mar. 24	24	47.6	113	22
2	Chenchow	" 30	25	48.0	112	59
3	Yunghinghsien	Apr. 1	26	09	112	58
4	Leiyang	" 2	26	24.6	112	42
5	*Hengchowfu*	" 5	26	55.0	112	33
6	Paoking	" 10–11	27	15.0	111	23
7	Wukangchow, *B*	" 15	26	43.6	110	38
8	Wukangchow, *A*	" 16	26	43.6	110	38
9	Yüanchow Hun	" 24	27	26.9	109	37
10	Chenki	" 28	27	58.9	110	07
11	Shenchowfu	" 30 – May 2	28	27.7	110	15
12	Changteh	" 5, 7	29	01.9	111	33
13	Tsingshih	" 10–11	29	38.3	111	48
14	Shihmen Hun	" 13	29	34.7	111	16
15	Tzeli	" 15	29	26.4	111	01
16	Yungting	" 18	29	07	110	22
17	Yungshunfu	" 22	29	00.8	109	53
18	Paotsing	" 25	28	43.1	109	49
19	Sungtao	" 29	28	10.6	109	14
20	Szenan	June 3–4	27	56.4	108	18
21	Meitan	" 9	27	46.3	107	33
22	Tsunyi	" 12	27	41.7	106	59
23	Sihfeng	" 16	27	06.5	106	45
24	Kweiyang	" 21	26	34.0	106	42
25	Tuyünfu	" 27	26	15.5	107	26
26	Lipohsien	July 2	25	25.1	107	47
27	Ta Tit Tsuen	" 5–6	24	59.9	108	06
28	Kingyüan	" 10	24	30.4	108	33
29	Liuchowfu	" 12–13	24	19.8	109	19
30	Siang	" 16–17	23	57.8	109	37
31	*Wuchow*	" 20	23	28.0	111	17

[1] The provinces in which the stations are located are as follows: No. 1, Kwangtung; Nos. 2–18, Hunan; Nos. 19–26, Kweichow; Nos. 27–31, Kwangsi.

On long overland stages it is preferable to purchase chairs for the party, as those hired from the coolies are sometimes in a dilapidated condition. In most places it is possible to live on the country, though some tinned meats, milk, and jams should be carried to help vary the somewhat monotonous diet of eggs, chickens, and rice. Good raincoats and stout marching boots are essential. A letter in Chinese should be obtained, if possible, through the consul when applying for the ordinary traveling passport, explaining exactly the object of the observations.

F. BROWN, ON MAGNETIC WORK IN MONGOLIA AND THE NORTHEASTERN PROVINCES OF CHINA, AUGUST 1915 TO JULY 1916.

Having made arrangements through my chief of party, Dr. C. K. Edmunds, for an extended expedition in Mongolia and adjacent provinces in the north of China, I left Canton August 4, 1915, with an instrumental outfit consisting of magnetometer No. 9, dip circle 177 with needles 1, 2, 5, and 6, pocket chronometer, two watches, aneroid barometer, observing tent, and miscellaneous equipment. As I was to meet Dr. Edmunds at Kalgan in Chihli Province, opportunity was afforded by the journey to secure a few stations en route.

One day was spent in procuring the necessary police permit to leave the colony and in securing passage to Shanghai, Shantung. At Shanghai a passport was received through the office of the British Consul-General which gave permission to travel in the provinces traversed on the way to Peking. I went by rail to Suchow An, Anhwei, where observations were made on August 11 and 12, and thence, with a stop of one day at Chufou to visit the home of Confucius, to Tsinan, where observations had been made by Dr. Edmunds in 1908, the new station being on the grounds of the proposed university.

We then went by boat to Litsinghsien, near the mouth of the Yellow River, where observations were made on August 19. The journey back to the railroad was made in two Peking carts which were hired from village to village, usually for one day stages. It was not possible to hire carts for the whole trip to the railway at Tehchow, because an arrangement among themselves forbade any carter carrying beyond the limits of his own district. We left Litsinghsien August 20, stayed over one day for observations at Wuting, and reached Tehchow on August 25.

The country throughout this journey was flat and intensely cultivated; long detours were often necessary to avoid flooded roads, and those that could not be avoided were sometimes 2 or 3 feet under water. The remainder of the trip was accomplished by rail after stopping 2 days at Tsangchow for observations, and 3 days at Peking procuring the necessary passports and introductions for the proposed work in Mongolia. On September 1, I reached Kalgan and reported to Dr. Edmunds, chief of party. The names of the stations occupied between Canton and Kalgan, with their positions and dates of occupation, are given below; for magnetic elements, see Table of Results.

TABLE 11.

No.	Name[1]	Date	Lat. North		Long. East	
		1915	°	′	°	′
1	Suchow An	Aug. 11–12	33	39.1	116	58
2	Tsinan	" 16	36	39.5	117	01
3	Litsinghsien	" 19	37	29.5	118	19
4	Wuting	" 22	37	29.4	117	34
5	Tehchow	" 26	37	26.9	116	26
6	Tsangchow	" 27–28	38	17.7	116	58

[1] No. 1 is in Anhwei Province; Nos. 2, 3, 4, and 5 are in Shantung Province; and No. 6 is in Chihli Province.

Following the general instructions given me here by Dr. C. K. Edmunds, I organized my party for the Mongolian work, taking with me Mr. Johansson, a Swedish missionary to the Mongols, to act as interpreter-companion, a Chinese cook, and a Mongol horseman.

After having purchased and packed the necessary stores and assembled the wagon which had been sent out from the United States, we left Kalgan, September 8. The four-wheel wagon belonging to the Department was only lightly laden in anticipation of the rough stony road through the pass leading from Chihli up to Mongolia. The greater part

of the equipment and stores was carried in a large Chinese cart, which was hired for the journey as far as Tabo Ol, the home of Mr. F. Larsen.

At Tabo Ol, where the party arrived on September 11, 6 horses were purchased from Mr. Larsen, 4 as mounts and 2 to draw the wagon. Breaking in the two fresh cart-horses to the foreign wagon proved rather disastrous, for they were not accustomed to double harness or center pole. Though hobbled, they were very wild and eventually broke several parts of the harness and also the center pole of the wagon. To save time, it was then decided to use Chinese harness and to make a pair of shafts from some wood kindly supplied by Mr. Hindli, a local missionary. Another Mongol was engaged at Tabo Ol as driver.

A start was made for Urga, September 15, in cold, wet weather, and the following day we were on the ox-cart road to Urga, which was followed generally for the remainder of the journey. The weather for the last half of September and the first part of October was fine and bright. It was often quite hot in the daytime, though cold at night. The road, except for a little sand encountered five days after leaving Tabo Ol, was very good, leading over plains of hard soil and undulating grassland. Wells were quite numerous as a rule, and the party was never short of water. Argol was used for fuel and was burned in small circular open fire-grates.

In a district of central Mongolia known as Derarangai, on September 30, a band of six outlaws stopped the wagon and demanded payment of 200 ounces of silver to allow the party to proceed. When this was not paid, the boxes and stores were searched and finally about 20 pounds in English money, a rifle, and various stores were taken by the chief, who said it would be safest to return, as the country ahead was being looted by a big band of robbers. It was then decided to travel only by night to the southern border of Outer Mongolia, which was reached on the third night, after two days of camping in gullies away from the road. Outer Mongolia proved to be quite peaceful, but there were very few caravans on the road, traffic between Kalgan and Urga having practically ceased.

The Kuerulen River was followed for a short distance on October 13, and from here to Urga, which was reached October 19, hilly country was crossed where feed for the horses was not very good. We stayed at Urga much longer than we had anticipated, occupying a Mongol house which was cold and disagreeable. Winter had already set in and the maximum temperature during the day seldom rose above freezing. Business is slow and the cost of living is high.

Mr. Johansson visited various camel owners and caravan men, but could obtain no information about a road to Liangchowfu, except that by going west from Urga roads could be found going south to northwestern provinces of China and Turkestan. All agreed that horses could not be used, owing to the very bad deserts and the utter absence of grass. The horses, therefore, were sold and the wagon stored at Urga, while eight camels were purchased for the next stage of the trip.

The caravan left for Liangchowfu November 11. The Chinese cook, fearing the cold, had left the party, but one of the Tabo Ol Mongols took up his duties. An Urga Mongol was engaged for the camels, while the other Tabo Ol Mongol assisted him and acted as "boy." Four camels were used as pack animals and three as mounts, while the remaining one pulled the camel cart, which was used by the observer for traveling by day and for sleeping by night. A southwesterly route was taken, and the caravan followed the Urga-Uliassutai courier road November 23 to December 5. The country was either mountainous or hilly, and was quite well watered and grassed. On December 6 the big roads extending south were still reported to be well to the west, but on finding a small track we decided to strike south and find the way by inquiring. On December 12, after having followed the track over very rocky country and having crossed a large plain without any road, a caravan route from Paotowchen to Kobdo was reached which

was followed southeast until December 19. Then a road south was found which, on inquiry, proved to be the caravan road from Northern Mongolia to Alashan Yamen and Tingyüanying, near Ningsiafu in Kansu. On January 1 Inner Mongolia and the Alashan Desert were reached, and Shartzan Sume Lamasery was visited January 3. Here the lamas told of a route to Liangchowfu which could be reached by cutting across country to the Chinese frontier city of Chenfanhsien. This route was chosen and the latter city reached January 16, after crossing a desolate sandy waste almost destitute of any kind of feed for the camels.

We arrived at Liangchowfu January 20, and after a few days' stay to rest and feed the camels, we took the main road south to Pingfan, where we arrived February 1. After observing at the C. I. W. magnetic station of 1909, the main road west was followed to Siningfu over the mass of high loess mountains where the roads are not suitable for camels and are often very dangerous, especially where the loess cliffs are crumbling and waterworn. Siningfu was reached February 8, where 5½ months' accumulation of mail awaited the party. After observing here, we continued on the road west to the Tibetan border (see view 8 of Plate 4), where observations were made at a large lamasery 10,500 feet above the sea, not far distant from Lak Koko Noi. Turning eastward, a route to Lanchowfu was followed through the famous Tibetan lamasery of Kumbum, Siningfu, and Hochow, the "Oxford" of Mohammedanism. We arrived March 6 at Lanchowfu, where the camels were given a good rest and feed.

From Urga to Liangchowfu the route can be divided into three stages: In Northern Mongolia feed and water were generally good when far from the Mongol encampments; view 3 of Plate 4 is typical of these encampments. The road, though often stony and rocky, is quite suitable for the camel cart (see view 1 of Plate 4). In central Mongolia and the Gobi Desert the rock-strewn plains alternate with desolate rocky ranges of hills. Feed is very poor, even for camels. Grass is scarce, but there are several varieties of bushes and thorns which are food for camels and sheep, but not for horses. The roads are not suitable for carts. Water is not found on the surface as in the north, and travelers must follow the caravan routes, where wells are usually not more than 20 miles apart, with water surprisingly close to the surface. South Mongolia and the Alashan Desert proved to be the hardest stage of the trip, for the country is an arid waste of sand, intersected in places by masses of wandering sand hills. Wells are fairly numerous, but there is very little good feed for camels. Camels may be used from Liangchowfu to Siningfu, but the road is more suited to mule teams. From Siningfu to Hochow and Lanchowfu camels should not be taken, for there are several steep high passes which are difficult even for mules. Moreover, the inns often object to camels, and when their doors and gates are low, the animal has to kneel down and be dragged into the courtyard.

While at Lanchowfu one of the camels died, chiefly of fatigue, and as the others were tired, three horses were purchased as riding animals, so that the riding camels could be made into pack animals, thus lightening the loads of the others. A start was made for the final stage back to Kalgan, March 23, the road leading for the first two days through loess hills, of which the valleys were cultivated. The remaining 6 days' travel to the city of Chungweihsien was over desert country with inns at intervals of 10 to 20 miles, which served to keep the road open. Soft sand makes it a poor road for carts, but being in flat country, it is well adapted to camel travel. Chungweihsien was reached April 2, and, after observing, the journey was resumed to Ningsiafu, through flat, irrigated farming country. A delay of ten days occurred at Ningsiafu, through the civil and military officials refusing to furnish escorts or to allow the party to proceed by the Yellow River route.

Arrangements had been made to sell the camels and proceed to the coast via Sianfu in Shensi, when the Mohammedan general returned from his operations against the

Mongol brigands who had been looting the Yellow River district northeast of Ningsiafu all the winter. Permission was asked of him to be allowed to proceed to Paotowchen, and it was given, provided that the party would not hold him responsible for damage by attacks if there was another sudden raid by the Mongol brigands on the country through which the road lay. Accordingly, on April 21 the journey was resumed by caravan and the village of Shihtsuishan reached on April 23. Observations were taken on the following day, after which we again traveled through desert country until our arrival at Paotowchen, May 16. Some sand was encountered, but the soil chiefly is a sandy loess, covered with coarse spear grass and occasional bushes. Settlements of Chinese emigrants are found occupied in farming and grazing. The farm land is irrigated from the Yellow River. The spring gales of this district were very unpleasant, filling the air with blinding clouds of sand and dust, obscuring the sky and Sun, and making observations very unpleasant and trying.

For the journey from Paotowchen to the railhead at Fengchen, 2 Peking carts were hired for the baggage and 2 for the Mongols. The remainder of the party rode their horses. We left May 19 and arrived at Kweihwating May 23, made observations, and continued 4 days to Fengchen. The road was generally good, passing through a flat country of scattered farms. From Fengchen to Kalgan the journey was completed by rail, observations being made at Tatungfu and Tienchen en route. The party arrived at Kalgan June 3, where it was disbanded. One Mongol returned by camel to Urga, while Mr. Johansson and the other two Mongols returned to Tabo Ol.

After reaching Fengchen the Mongols were treated with suspicion by the Chinese soldiers, and had it not been for foreigners accompanying them, they would have been arrested several times. The trip on the whole was a success, and an enjoyable time was spent even in the desert. Mr. Johansson proved to be a very capable companion, and the success of the trip is in large part due to him.

Table 12 (see p. 111) gives list of stations occupied, with dates and geographic positions; for magnetic data, see Table of Results.

The field time of occupying these 60 stations was 268 days, making an average of 4.5 days per station. The distance traveled was approximately 3,718 miles, which gives an average of 61.9 miles per station. The average cost per station was $34.

The magnetic conditions generally were good. Between Kalgan and Urga the results obtained at Cholo Kobor and at Eekhun Buyer Well seem to indicate a slight local disturbance. Between Urga and Liangchowfu a local disturbance is indicated at Arra Hottock and Tayik Hyhun. In the loess mountain region from Liangchowfu to Siningfu the results obtained are very regular. Between Liangchowfu and Kalgan a magnetic disturbance is indicated at Huangyang Motto and Paotowchen. The magnetic stations at the former place and also at Patsebolong are on a large sandy loess plain, but at Chahgar Tzu Tien and Paotowchen the Wala Shan, a big rocky sandstone range, is quite close.

Mr. A. Miller, the Russian Consul-General at Urga, extended every courtesy and took a kindly interest in the expedition. The missionaries of the China Inland Mission stations in Kansu were most helpful and hospitable, often voluntarily offering themselves as interpreters in necessary business with officials and merchants, and putting their stations at the disposal of the party. The kind services of Mr. W. Belcher at Liangchowfu, Mr. H. F. Ridley at Siningfu, Mr. G. F. Andrew at Lanchowfu, and Mr. J. F. Fiddler at Ningsiafu were especially acceptable. Kindness of the Swedish and Scandinavian Alliance Mission stations in Shansi and also the Swedish Holiness Union is gratefully acknowledged.

If a foreign wagon is to be used in future work, it should have shafts and not a center pole. A Chinese harness is preferable to a foreign one, for the cart horses are accustomed

TABLE 12.

No.	Name[1]	Date	Lat. North		Long. East	
		1915–16	°	′	°	′
1	Tabo Ol	Sept. 12–14	41	45.1	114	08
2	Cholo Kobor	" 17	42	20.8	114	02
3	Soom-in Bollock Camp	" 20	42	52.4	113	29
4	Gol Derris	" 21	43	00	113	18
5	Errin Gosso	" 24–25	43	24.4	112	56
6	Olang Oobos Well	" 28	44	17.5	113	11
7	Haragan Jeerum Well	Oct. 3–4	45	48.1	111	19
8	Eekhun Buyer Well	" 6	46	08.5	110	42
9	Soolt Shunt Well	" 9	46	33.0	109	49
10	Hallchin Holer	" 11–12	46	52.5	108	59
11	Booralchin Temple	" 16	47	22.3	107	44
12	Urga	" 25–26	47	55.6	106	52
13	Jeerum	Nov. 14–15	47	54.7	105	57
14	Tola Gol	" 18–19	47	42.4	105	05
15	Arra Hottock	" 21	47	17.0	104	41
16	Goosut Ussu	" 25	46	52.0	103	47
17	Boskhun Bollock	" 28–29	46	37.0	103	02
18	Chockhurt-in Dava	Dec. 1	46	17.4	102	35
19	Uhtergar Narin-in Gol	" 4	45	53.1	101	53
20	Hushurt-in Sire	" 7	45	34.8	101	08
21	Tarn-in Sire	" 10–11	44	57.5	101	05
22	Choahr Ussu	" 13	44	33.4	101	30
23	Olang Sire	" 17	43	53.3	102	17
24	Hushurt Hottock	" 20–21	43	32.1	102	59
25	Tayik Hyhun	" 23	43	04.9	103	32
26	Olang Dill Hottock	" 26–27	42	29.2	103	56
27	Gusson Togurik	" 29	42	52.1	103	57
28	Sokhontay-in Gol	Jan. 1–2	41	11.0	104	13
29	Tchagan Toonke Hottock	" 4	40	46.3	104	31
30	Illice-in Honkor Well	" 8	40	27.1	104	12
31	Hungmachia	" 13	39	18.5	103	51
32	Chenfanhsien	" 17	38	37.5	103	16
33	Liangchowfu	" 24–27	37	55.4	102	44
34	*Liangchowfu*	" 26	37	56.8	102	45
35	*Chengchang*	" 30	37	09.5	103	04
36	*Pingfan*	Feb. 2	36	44	103	26
37	Kaomiaotzu	" 6	36	25.8	102	42
38	Siningfu	" 10	36	37.3	101	56
39	Tungkwossu	" 13	36	31.0	101	16
40	Payenjungke	" 25	36	05.0	102	21
41	Hochow Kan	Mar. 2–3	35	36.2	103	14
42	*Lanchowfu*	" 17, 23	36	03.4	103	48
43	Hokei	" 27	36	55.7	103	44
44	Yingpanshui	" 30	37	26.5	104	18
45	Chungweihsien	Apr. 3	37	30.6	105	08
46	Chükopu	" 6	37	40.0	105	50
47	Ningsiafu	" 11–19	38	28.3	106	13
48	Shihtsuishan	" 24	39	13.8	106	46
49	Tongkow	" 27	39	55.9	106	43
50	Huangyang Motto	May 2	40	40.0	107	10
51	Hsiung Wan Ku Tsun	" 5	40	56.0	107	49
52	Patsebolong	" 10–11	40	50.9	108	37
53	Chahgar Tzu Tien	" 14–15	40	36.8	109	16
54	Paotowchen	" 17–18	40	35.5	109	59
55	Tao Ssu Ho	" 21	40	37.1	110	52
56	Kweihwating	" 24	40	48.9	111	38
57	Niu Chüeh Chüan	" 27	40	41	112	28
58	Fengchen	" 30	40	25.4	113	06
59	Tatungfu	June 1	40	06.4	113	13
60	Tienchen	" 3	40	26.2	114	01

[1] Provinces in which these stations are located are as follows: Nos. 1 and 2, Chihli; Nos. 3–6, Inner Mongolia; Nos. 7–27, Outer Mongolia; Nos. 28–31, Inner Mongolia; Nos. 32–48, Kansu; Nos. 49–51, Inner Mongolia; Nos. 52–58, Kweisuitao; Nos. 59 and 60, Shansi. Kweisuitao is a new province formed of territory outside the great wall and having its capital at Kweiwating.

to it, and repairs can more easily be effected. From inquiries made, it was learned that travel by wagon is practicable from Urga to Uliassutai and from Urga to Hailai. In other parts, except for the roads from Kalgan to Urga, a camel caravan is the best way to travel, and is essential for successful trips in southwestern Mongolia. If possible, trips in Mongolia and China should not be combined, for Mongols do not like the Chinese and object to living at inns. Meat can always be purchased at Mongol camps, so that it is unnecessary to carry any quantity of tinned meat. Dried fruit should be carried, for neither fresh fruit nor vegetables can be procured. For trading with the Mongols for sheep or even horses, sheath knives, chopsticks, and snuff bottles are the best and least bulky articles to carry. A rifle and a shotgun for shooting antelope and water-fowl should be included in the equipment.

After disbanding the Mongolian party, I proceeded to Peking, reporting to Dr. Edmunds, and began my preparations for the Manchurian expedition. Time was allowed in the interval to occupy the stations named in the following table.

TABLE 13.

No.	Name [1]	Date	Lat. North	Long. East
		1916	° ′	° ′
1	*Kalgan*	June 7	40 51	114 51
2	*Peking*	" 16	39 52.5	116 23
3	*Tientsin*	" 28	39 05.9	117 11
4	Lwanchow	July 1	39 46.0	118 46
5	Pehtaiho	" 3, 7	39 49.5	119 29

[1] These stations are all in Chihli Province.

F. BROWN, ON MAGNETIC WORK IN MANCHURIA, JULY TO OCTOBER 1916.

After completing the Mongolian work already described, complying with instructions received through my chief of party, Dr. C. K. Edmunds, I next undertook an expedition along the railways of Manchuria. My instrumental outfit consisted, as hitherto, of magnetometer No. 9, dip circle No. 177 with 4 needles, pocket chronometer, 2 watches, aneroid barometer, observing tent, and miscellaneous equipment.

We started from Pehtaiho on July 11, 1916, making a short journey by cart to Funinghsien, a small town about 17 miles west of Pehtaiho, where Fritsche made magnetic observations in 1883, returning the following day to the nearest station on the Peking-Moukden Railway.

From this point the expedition followed the railway northeastward into Manchuria as far as Kowpangtze, where a branch line by way of Newchwang connects the Peking-Moukden Railway with the main line of the South Manchurian Railway from Dairen to Harbin. After calls had been made on the British and Japanese Consulates at Newchwang, permission was readily obtained to make observations in the Kwantung Leased Territory. From here our route was southward to Dairen and Port Arthur. At Dairen permission to make observations was obtained from the Japanese police authorities through the kind offices of the American Consul, Mr. A. A. Williamson, who also assisted in the difficult task of securing a suitable site for the magnetic station. On the following day I proceeded to Port Arthur, accompanied by Mr. Williamson, where we gained an interview with the Governor-General, who gave the necessary permission to observe at that famous fortress.

Returning to Dairen on August 2, passage was taken on the steamer *Saitsu Maru* for Antung at the mouth of the Yalu River on the border of Chosen (Korea). Leaving Antung our travel was again over the railway northwestward to Moukden, which was

reached on August 13. Observing first at nearby points on the railways radiating from Moukden, the South Manchurian Railway was followed northward as far as Kwanchengtze, thence eastward over a branch of the Chinese Eastern Railway to Kirin, where observations were made on September 9.

After completing the work at Kirin, the journey was continued northward over the Russian railway to Harbin. Hitherto a knowledge of Chinese or English had been sufficient for traveling by rail, but on the Russian railways in Manchuria a knowledge of the Russian language is necessary. At Harbin permission to observe was readily obtained from the Russian Consul-General, who kindly introduced me to the engineer in charge of the Russian Eastern Railways and to Mr. A. Pavloff, the Director of the Meteorological Observatory. Through the kind interest of these officials a general letter of introduction for the party was written in the Russian language which proved of great value in our intercourse with the police and railway authorities en route, and valuable information was gained respecting the work done by Russian observers.

Leaving Harbin on September 18 we proceeded to Tsitsihar Station and thence by the Chinese Light Railway to Tsitsihar City, where we were very hospitably received by the Russian Consul, Mr. Afanasiew. The consulate interpreter, Mr. Chang Da Min, by the kind permission of Mr. Afanasiew, accompanied the party for the remainder of the journey west of Harbin, and proved very helpful in our meetings with the officials to whom it was necessary to report arrival and from whom permission to observe was obtained. After making observations at Buchedu and Hailar we arrived at Manchouli on the Siberian border, where observations were made on September 27. The next morning we started on the return journey, reaching Tsitsihar on September 29. Here we left Mr. Chang Da Min and proceeded to Harbin.

After occupying Imienpo, the contemplated work at other points along the railway from Harbin to Vladivostok was omitted by telegraphed instructions from the chief of party, and we returned directly to Pehtaiho, arriving there on October 4.

With the exception of a short cart journey at the beginning of the trip and the 200 miles between Dairen and Antung which was made by sea, the entire journey of about 3,500 miles was made by rail. No delay was caused by the war, owing chiefly to the numerous letters of introduction secured by the chief of party, Dr. C. K. Edmunds, and also because of the interest taken by the various American Consuls, who advised the railway officials of the party's itinerary. A large supply of stores is not necessary on any part of the trip, and with a capable "cook boy" travel should present no difficulties.

Although the months of July and August are the rainy season in this region, there were no long delays occasioned by wet or cloudy weather. September was generally fair, though there were many cloudy days. In Manchuria near the railways as elsewhere brigandage was rife, the "kao liang," a crop growing to the height of 10 to 12 feet, making an ideal hiding place for bands of armed robbers. Even the outskirts of large towns like Moukden and Kwanchangtze are considered unsafe.

The total distance covered on this trip was 3,548 miles, all but about 230 miles being by rail; the average travel per station for the 35 stations was 101 miles, and the average distance between stations is a little less than 50 miles. The party left Pehtaiho on July 11 and returned on October 5, 1916, after an interval of 87 days, thus making the average field time per station about 2.5 days. The average field expense per station was $13.21.

Leaving Pehtaiho, the railway first passes near the foot of a range of mountains; further on it passes through isolated granite hills where hot springs abound, then enters a gently rolling country near Chinchowfu, and finally passes on to a flat region where the soil is a loamy clay in the neighborhood of Kowpangtze. This flat country extends southeasterly from Kowpangtze beyond Newchwang, again becoming hilly as one approaches the Kwantung Leased Territory. Near Port Arthur it is somewhat mountainous, and

magnetite is found in certain localities. The region between Antung and Moukden is very hilly, the formation being limestone or sandstone, and both coal and iron are mined near Nanfen. From Moukden to Harbin the country is gently undulating, but Kirin is situated in a very hilly district, probably of volcanic origin, while Imienpo lies among low, wooded hills. Northwest of Harbin and beyond Tsitsihar the country is one vast steppe with no trees or cultivated lands. Between Buchedu and Hailar the railway crosses the Khangan range said to contain a variety of minerals, while beyond Hailar to the Siberian border the country is open and undulating with deposits of coal and iron near Manchouli.

Table 14 gives a list of stations occupied, with dates and geographic positions; for magnetic data, see Table of Results.

TABLE 14.

No	Name [1]	Date	Lat North	Long East
		1916	° ′	° ′
1	Funinghsien	July 11–12	39 54 2	119 13
2	*Shanhaikwan*	" 13–14	39 58 3	119 45
3	Ningyuanchow	" 14–16	40 38 1	120 42
4	Chinchowfu	" 17–18	41 09 3	121 09
5	Kowpangtze	" 19	41 22 0	121 44
6	Shwangtaitze	" 20–21	41 12 3	122 02
7	*Newchwang*	" 24	40 40 3	122 13
8	Siongyocheng	" 25–26	40 10 7	122 08
9	Pulantien	" 27	39 24 3	121 59
10	Kinchow	" 28	39 07 4	121 43
11	Dairen	" 30	38 55 2	121 39
12	Port Arthur	" 31, Aug 2	38 49 0	121 14
13	Antung	" 5	40 09 3	124 23
14	Fenghwangcheng	" 7–8	40 28 1	124 04
15	Tsachokow	" 11	40 53 0	123 56
16	Nanfen	" 12	41 06 2	123 47
17	Moukden	" 14–16, 29	41 49 7	123 28
18	Sinminfu	" 19	41 59 6	122 52
19	Liaoyang	Aug 22–23	41 17 0	123 13
20	Haicheng	" 24	40 51 5	122 47
21	Tiehling	" 30	42 19 4	123 54
22	Kaiyuan	" 31, Sept 1	42 33 2	124 05
23	Szepingkai	" 4	43 11 4	124 26
24	Fanchiatun	" 5	43 43 2	125 06
25	Kwanchengtze	" 6–7	43 56 3	125 21
26	Kirin	" 9	43 51 0	126 36
27	Harbin, *A*	" 14–16	45 44 0	126 43
28	Harbin, *B*	" 17	45 44 0	126 43
29	Tsitsihar Station	" 18–19	47 09 4	123 51
30	Tsitsihar	" 20	47 21 7	123 59
31	Buchedu	" 22	48 46 2	121 57
32	Hailar	" 24	49 13 7	119 45
33	Manchouli	" 27	49 35 7	117 28
34	Anda Station	" 29	46 24 8	125 20
35	Imienpo	Oct 1	45 05 2	128 07

[1] Stations Nos 1 and 2 are in Chihli, all the others are in Manchuria The Manchurian stations are distributed as follows: Nos. 3–8, and 13–24, Shengking, Nos 9–12, Kwantung Leased Territory; Nos 25–28, and No 35, Kirin, Nos 29–34, Heilungkiang.

Grateful acknowledgment is made of the active interest shown and assistance rendered by the railway authorities at Harbin and of the valuable information supplied by the Director of the Meteorological Observatory. The success of the expedition was largely due to the courteous and efficient assistance rendered by the various American and Russian consuls in Manchuria, while the hospitality of the Irish and Scotch Presbyterian Missions contributed largely to the pleasure and comfort of the expedition.

F. BROWN, ON MAGNETIC WORK IN THE SOUTHWESTERN PROVINCES OF CHINA AND UPPER BURMA, NOVEMBER 1916 TO JUNE 1917.

Having met my chief of party, Dr. C. K. Edmunds, at Pehtaiho in October 1916, I made preparations in accordance with his instructions for an expedition to the extreme southwestern border of China, hoping to reach Bhamo on the Irrawaddy River in Upper Burma. With the exception of dip circle No. 206 with needles 1 and 2, and needles 5 and 6 of circle 178, replacing dip circle No. 177 which had met with an accident in Manchuria, and with the addition of a boiling-point apparatus, my instrumental equipment was as hitherto. Mr. Y. T. Wu, a graduate of Nanking University, was taken as interpreter-companion. After making observations at Pehtaiho, I proceeded to Chungking, where I arrived November 24, having made reoccupations of previous magnetic stations at Hankow, Yochow, and Ichang, en route.

As the river journey would be more expeditious and safer than an overland route through country held by brigands, I engaged passage on a small launch which was leaving Chungking on her maiden trip at daylight, November 26. Mr. C. Neprud of the Chinese Maritime Customs was most helpful, and it is entirely due to his efforts that the owner of the launch *Yüan Chi* promised to remain one whole day at Luchow and a few hours at Kiangtsing to enable observations to be made. In return I was expected to place myself in a prominent position on the deck if brigands should fire on the boat. Chungking and its teeming thousands were left shrouded in a dense mist on the morning of November 26, when the journey to Suifu, about 200 miles up river, began. The engineer, however, could not get the engine to work properly, very slow time was made, and Luchow was not reached until the evening of November 29. The trip from Luchow to Suifu lasted from daylight on December 1 to the afternoon of the next day, much better time being made on this stage of the journey. Brigands were seen running along the banks at one place, but we were not called upon to stop.

Between Chungking and Suifu the river winds through low red sandstone hills, and is about one-fourth mile wide. There are numerous rapids, but none is dangerous, and the launch had no difficulty in ascending them. Occasional villages, often surrounded by picturesque clumps of bamboo, line the banks. The chief town on this stretch of river is Luchow, built at the junction of the Lu River with the main stream. Luchow has a population of about 100,000, and is 130 miles above Chungking. Salt and sugar come down the small river and are transshipped at the city into larger boats.

At a half-day run above Luchow is the small picturesque city of Kianganhsien, with its numerous pagoda-shaped roofs and towers, built on a low sandstone bluff on the right bank of the river at its junction with the Anning Ho. It is famous as the center of the district growing the "chü sen," vegetable bamboo shoots, which are very delicious and considered a luxury in other parts of China.

December 2 to December 8 was spent in Suifu completing the observations and hiring a caravan of coolies for the overland journey of 23 days to Yünnanfu. The city of Suifu, built at the junction of the Min River with the Yangtze, is about 1,600 miles up river from Shanghai. Steam navigation on the main river ends here, but foreign gunboats have ascended the Min to Kiatingfu, by which river it is possible to go within a few miles of Chengtu in small boat. Suifu is a shipping point for hides, skins, and pigs' bristles from the hinterland.

The caravan, consisting of 9 chair-bearers, 12 load-carriers, and a head man to manage the coolies, started after tiffin, December 8. The local authorities insisted on sending an escort of 36 soldiers and an officer to protect the party on account of the activity of a band of brigands who held the pass between the provinces of Szechwan and Yunnan. The road followed the bank of the Yangtze to the little market town of Anpien, 36 miles from Suifu. The Yangtze, locally known as the "Kin sha" (River of

Golden Sand), was left, and the little river, the "Heng Kiang," was followed until December 16. The scenery is of great beauty, the stream flowing through fine gorges of limestone and sandstone (see view 2 of Plate 1).

The only place of any importance passed was the little town of Laoyatan, on December 13, to which point small boats can ascend the Heng River in the high-water season. The pony caravans from the south do not go beyond this point, where their loads of tin, pewter, and zinc, and also herb medicines and tea are exchanged for salt, paper, cloth, and sundry articles from Szechwan, which have been brought down by coolie caravans. A road crosses from Laoyatan to the Nan Kiang River, which flows into the Yangtze a little below Suifu.

Continued wet weather prevented astronomical work at Tantow Yun, Puerhtu, Towshakwan, and Takwan. Approaching Takwan, the road leaves the river and runs obliquely up the side of a small valley to the city, and then, by a very steep pass with a very difficult road, climbs to an altitude of 5,500 feet to the Yunnan plateau. When finally on this plateau, the miserable cold wet weather of the Yangtze valley was left behind, and bright clear weather prevailed to the end of the journey.

Chaotung Yun, reached on the afternoon of December 20, marks the end of the most difficult section of the Suifu to Yunnanfu trip. It is not a large city, though there is none larger between Suifu and Yunnanfu, and it is quite young for China, having been built but 200 years; there are few local industries, though cloth weaving is becoming important, and tin and zinc are mined in the surrounding regions. On December 23 the journey was continued toward Tungchwan Yun, a walled city 5 days to the south, descending 3,000 feet on the afternoon of December 24 from an elevation of about 7,200 feet at Tashuiching to Kiang Ti, a small hamlet on the bank of the Niu Lan River, whence the ascent was gradual to Yichesun at an elevation of 5,500 feet. The road then leads over undulating red broken country often covered with groves of fir trees at altitudes varying from 5,600 to 7,700 feet above sea-level.

Tungchwan Yun, a small walled town with a few shops in the main street, was reached on the evening of December 28. Copper mined in the surrounding country is the chief source of wealth. The Ya Kow Pass was crossed December 31 at an elevation of about 9,300 feet, and the village of Laitowpo reached in the afternoon. Leaving Laitowpo, the road crosses red uplands at an elevation of 8,000 to 8,600 feet, then descends about 2,000 feet to the hamlet of Hsiao Lung T'an. The remainder of the way to Yunnanfu undulated over red uplands, dotted with occasional small hamlets and villages.

The road from Suifu to Yunnanfu is a main caravan route, and mediocre inns are found throughout. It is very bad between Suifu and Chaotung Yun, the ascents and descents being difficult in wet weather. Between Chaotung Yun and Yünnanfu there are frequent good stretches over uplands where the road is not paved, and is, therefore, easy for travel in dry weather (see view 4 of Plate 1). The weather was wet and cold to December 20. After that date fine bright weather prevailed, with frosty nights and cool days, the temperature at midday varying from 5° C to 15° C, in the shade. The people are friendly to foreigners and are devoid of the persistent curiosity of their countrymen in other parts of China. Chickens, eggs, and vegetables may be purchased at most places, and sugar, flour, tea, tinned milk, etc , can be obtained at Chaotung Yun and Tungchwan Yun.

We stopped at Yunnanfu January 6 to January 13. There are several foreign stores at Yunnanfu, selling a great variety of tinned foods, from which we purchased a supply of provisions. The coolies from Suifu were paid off, and arrangements made to hire pack animals to Talifu, a journey westward of 13 days. The usual price for mules in most parts of Yunnan is 50 cents per day, each animal carrying a load which must not exceed

120 catty (about 160 lbs.). The caravan, consisting of 6 baggage animals and riding horses for myself, Mr. Wu, and the cook, started for Talifu on January 13.

Two days, January 16 and 17, were spent to make diurnal-variation observations in addition to the usual work at the small walled city, Lufenghsien, whose stone bridge outside the west gate is said to be the finest in Western China. The next halt for observations was made at Kwangtunghsien, also a small walled city, half in ruins. The following day, January 20, 6 days' travel from Yünnanfu, the caravan arrived at Tsuyung, a walled city, and one of the largest places seen on this expedition, though small in comparison with the cities of central and south China.

A long day's march was made on January 21 to Shakiao, a market village, where numbers of Lolos had come in to make their Chinese New Year purchases. A further 2 days' march over mountainous country led into the plain of Yunnanyi, where observations were made without causing delay. We now left the main road, taking a smaller one to Liang Wan Shan, from which place Chaochow was reached in one day. The usual route takes 2 days from Yunnanyi to Chaochow, but the road is rougher and longer. Between Liang Wan Shan and Chaochow a pass, very steep and difficult for loaded animals to climb, was crossed at an elevation of about 9,000 feet. The main road is probably a better route. A market was being held in Chaochow, a walled city of no great size, and the streets were crowded with tribespeople from the hills.

Talifu was reached on the afternoon of January 27, the business suburb of Siakwan having been passed one and three-fourths miles to the south of it during the day's march. Talifu is most beautifully situated on the west shore of a large lake shut in on every side by mountains. Immediately behind the city rise the mighty Tien Tsang mountains, the upper peaks of which are 14,000 feet above sea-level, while Talifu has an altitude of about 6,800 feet. Another caravan of 9 horses was obtained here for the 12 days' journey southwest to Tengyueh, though, according to the map, the distance between the two towns is but 115 miles. The intervening country is a mass of high ridges extending north and south. Travel is, therefore, an alternation of long ascents and descents. The altitude of the road varies from 2,300 at Salween River to 7,000 and 8,500 feet at the passes. Leaving Talifu the road returns to Siakwan, and thence rounds the south end of the Tien Tsang range to Yangpi, which is about 11 miles, as the crow flies, from Talifu. By road, however, the journey lasted from the afternoon of February 3 to the evening of the 5th. The next evening we came to the Lolo hamlet of Taipingpu, after a long steep climb out of the Yungpi valley; more mountainous country was crossed during the next few days to the market village of Shanyang Yun; the march next led into the valley of the Mekong River, which is shut in by wall-like ranges forming a narrow gorge. Both the descent to and ascent from the chain suspension bridge by which it is crossed are very steep and difficult.

On the evening of February 12 we arrived at the city of Yungchang, whose walls inclose a large area, the greater part of which is given over to rice fields and vegetable gardens. Yungchang is quite busy, and numbers of foreign articles are for sale on the main street. The place is interesting historically, for this is where the Mongol soldiers of Kublai Khan defeated the Burmese, who attacked them on elephants. Leaving Yungchang on February 13, the Salween River was crossed by the chain suspension bridge on the afternoon of the 14th, and Homushu reached after dark the same day.

Two more days' mountain travel was then made to Tengyueh, which was reached February 18. The Shweli River had been crossed the previous evening, after a descent of 3,700 feet from the Shweli-Salween divide, which is known as the Kao Li Kung range. We remained at Tengyueh from February 18 to the morning of February 22. The walled city is not a half mile square, and contains but few shops. The business section of the city is outside the south gate, where various foreign goods are displayed for sale.

Tengyueh is noted for jade, which comes from upper Burma, and is cut and polished here. Besides the green-colored stone so popular with the Chinese, purple and blue shades can be purchased. The Talifu caravan was discharged and another engaged for the 7½ days' journey southwest to Bhamo on the Irrawaddy River in upper Burma. Starting February 22, we descended large rice-growing valleys inhabited by Shans to within a few miles of the Burma frontier. Manhsien, the last village in China, was reached on the night of February 25, and the next day we traveled over hilly country which was covered with thick forest and jungle. The road followed down the left bank of the Taiping River, which enters the Irrawaddy at Bhamo. A small iron bridge across a mountain stream about 50 miles from Bhamo marks the frontier, and we entered upper Burma in the afternoon on a good road. From here on, the bungalows of the Public Works are found every 10 to 15 miles. They are furnished with beds, baths, chairs, tables, crockery, etc., and are greatly appreciated by the traveler coming in from China.

Observations were made at Kulonghka on February 27 and 28, and Bhamo was reached about noon March 1. The Indian Survey station was located in the afternoon, and observations made the next day.

The road from Yünnanfu to Bhamo, a journey of 33 days overland, is a main caravan route and inns are found at the end of every stage. Faster travel is not practicable, owing to the lack of places affording accommodations for caravans between stages, while two stages a day are too much for loaded animals. There is very little coolie traffic on this road, and the farther west one proceeds, the more expensive is coolie hire. Chickens, eggs, and vegetables can be bought throughout. Fruits, chiefly oranges, were also obtainable as far as Tengyueh, where pineapples and bananas could be procured. The road is very rough, especially on the steep passes beyond Talifu. Fine weather prevailed from Yünnanfu to Talifu, after which spells of wet weather occurred to the Burma frontier. This was most unusual, for in Yunnan fine bright weather ordinarily prevails from November to the end of May. The wet season begins in the latter half of May and lasts until the end of October. The heaviest rain falls in July and August, when traffic practically ceases on many routes on account of the deadly malarial fevers and plagues in the low-lying valleys.

From Bhamo to Szemao there is no direct route, and the roads to be followed are often hardly discernible and are difficult to climb. There are no inns, and the country is inhabited chiefly by Shans and various hill tribes, some of the latter being still very primitive. Leaving Bhamo on the morning of March 12, the main road to Namhkam was followed for 53 miles to the bungalow at Panghkam, where we arrived March 14. Next morning a road was followed leading eastward into China, and Mengmow reached the same evening.

On March 17 the Shweli River was crossed, the horses swimming and the loads going in a long canoe. The night was passed at Wan Ting, a hamlet of about five bamboo houses. The route now lay through the Shan states of Chefang and Mangshih, after which mountainous country was crossed to Pingka. No guide could be obtained at Pingka, and travel during the next few days was difficult in the sparsely settled mountainous country, where considerable time was lost in following the wrong tracks. The Salween River was crossed by a bamboo raft at the Hankuai ferry, March 25, after which a climb of about 4,000 feet followed, and more mountainous country was crossed, when a fairly big track was found leading south. This was followed to Mengpeng, though a more direct road leads eastward through Mengpun. These two names are pronounced alike to the foreign ear, and thus it was that, though wishing to proceed to Mengpun, the party was directed to Mengpeng, which was said to be on the main road to Kengma. We, therefore, followed the road to Kengma, passing through Mengtui and Nahsang, the latter of which is but a few miles from the Burma border. Arrangements were made

with the chief at Nahsang by which the party was to be led to Kengma with change of guides from village to village. On the route the valley of the Namting was reached and followed to the Shan village of Szefangching, which is situated on the old road between Talifu and Mandalay. After crossing this plain, one of the lowest portions of Yunnan, 1,900 feet above sea, and also climbing a pass of 6,500 feet altitude from the Nam Ting valley, we finally arrived at Kengma April 4. Kengma is the capital of the Shan state of the same name and is the seat of the Sawbwa. It has a few shops and business is transacted mostly at the market every 5 days. The Sawbwa was most friendly, and urged the party to stay a few days as his guests. Being pressed for time, his invitation had to be declined, and the journey was resumed after tiffin.

From Kengma the direct road leads east to Weiyüan and thence south to Szemao, but Major Davies's map shows an alternative route through Chüanlo on the Mekong River more to the south. We could get no information concerning such a road, and were also advised to take the main route east, as there was fighting with the head-hunting Was to the south on the Burma frontier.

Accordingly, the direct road east was followed, passing through Kanfang and Mengmeng. The main route was now left and a small road was taken to the Shan capital of Mengpan, where we arrived April 12, after a southeasterly march of 5½ days, during which high mountains were climbed by a very rough and steep road. The Mekong River was crossed at the Tahuan ferry in a punt, and the horses were forced to swim. The country all the way from Kengma had been formerly inhabited by the La tribe, who were conquered by the Chinese. The latter have settled in the mountains, while the Shans are found in the valleys, those to the east of the Mekong wearing a costume different from those to the west. Continuing from Mengpan to Szemao, we passed through Mengchu on April 13, formerly a Shan place but now peopled entirely by Chinese, and the Puman village of Pa Te on April 14. Two more days of mountain travel finally brought the caravan to Szemao, a treaty port in the far southwest part of Yunnan. Arrival here ended the roughest but most interesting stage of the journey across southern China to Canton from Burma. The nights had been spent in all kinds of places, ranging from Sawbwa's palaces to sheds used for storing coffins and farming implements. Among the Shans it is usual for travelers to stay at the monasteries, where no money is accepted for the accommodation. In the hills the chief or headman usually has a small house or shed for the use of official visitors. Europeans, however, prefer to camp throughout the journey. The so-called roads over the mountains are but narrow tracks, and guides are absolutely necessary. Practically all supplies must be purchased at the 5-day markets, but chickens and eggs can be obtained at most places, though the Shans are not always willing to sell. The people were very friendly, but often timid and shy. They are not inquisitive or curious, and often take no notice of the foreigner.

It was now necessary to press on and complete the 36 days' overland journey to Kwangsi before the dreaded wet season broke. A start was accordingly made April 20 for Mengtsz, 18 days' travel towards the east, and the old prefectural city of Puerhfu was passed the following day. Puerh tea is extensively grown in the district and sent to Szechwan by coolie and horse caravans. On April 23 an ascent of 1,700 feet was made to pass above Mohei, where there are large salt mines from which the salt is sent to various parts of the province by pack-horses.

Leaving Mohei April 24, 4 days of very mountainous travel led through the Chinese village of Tungkwan Yun, and then to the walled city of Talang, which is situated in the middle of a district inhabited by the Wo Ni tribes. The town has outgrown its original mud wall, but it is yet quite small and contains no large shops.

Travel from Talang to Yuankiang by the main road takes 3 days, but we followed a smaller road which reduces the time to 2 days, and, after a descent of 4,000 feet, arrived

while a bad dust storm was in progress. The plain has the low elevation of 1,500 feet and is inhabited by Shans. Chinese live in the city, which is inclosed by dilapidated walls of mud. There are a number of shops on the main street, but the place lacks any special interest except the picturesque dress of the Shan women who bring in fruit and vegetables to sell in the streets.

The main road to Yünnanfu continues north from the city, crossing the Red River by an iron suspension bridge a few miles up the valley. The Mengtsz road crosses the river outside the east wall of the town by ferry, and then continues directly up the steep mountains bounding the plain on the east. The road is very steep and only permits of a day's travel of 10 miles being made, during which a continual ascent of 4,600 feet is made to Lutungpu. Leaving Lutungpu, the road continues to climb a few miles farther to an altitude of 7,700 feet above sea level, or 6,000 feet above the Yüankiang plain.

During the morning of May 3, a band of about 25 brigands was encountered in a ravine in the mountains, but by a merciful Providence the party was allowed to proceed unmolested. The same evening the large village of Paosiu was reached, and from here to Mengtsz the road undulated over red uplands or along cultivated valleys. The large town of Shihpingchow was passed on May 4, and on May 5 we arrived at the larger city of Linanfu. Linanfu has no special industry, but derives its wealth from the rich tin and silver mining district around. The main street and south suburb are lined with good shops. The country around was infested with brigands who had become so bold and daring that camps of soldiers had been established every few miles along the main roads. For the remainder of the journey the party was escorted from station to station by small bands of soldiers.

Mengtsz was reached shortly after noon May 8, after a three days' journey from Linanfu. Mengtsz is a treaty port near the French railway running from Haiphong to Yünnanfu, and has a foreign concession with a French consul, two hotels and three foreign stores. The Chinese city is lighted with electric lamps and is quite neat. The walls inclose yamens and residences, the business section being located outside. Observations were finished May 9, after which a visit was made to the Taoyin to make inquiries concerning routes into Kwangsi, as it was rumored that brigands were numerous and travel was unsafe. The official was most courteous, and after endeavoring to persuade the party to travel to Tongking by rail and thence enter Kwangsi at Lungchow, a much easier and safer trip, he promised to send an escort as far as Kaihwafu, 4 days' journey to the east. Arrangements were made for leaving, and a fresh caravan was hired for the remaining 17 days' overland journey to the river at Poyai.

Starting on May 13, we found the road an easy one in dry weather. The country is a mass of limestone hills rising from rolling red uplands. Brigands were quite active, and on May 15 an extra escort of 16 men joined the party. Kaihwafu, where we arrived May 16, is a small city, built on a plain surrounded by limestone ranges. The walls inclose residences and yamens, the shops being found outside the west gate. Lung Ren (Shans) inhabit the plains of this district, while a number of tribes are found in the hills, the chief being Lolos and Miao.

Between Kaihwafu and Kwangnanfu, a 4-days' journey, the region is dotted with limestone hills. The uplands produce shellac and grow wheat and peas, while the irrigated fields grow rice. Kwangnanfu is a large city for Yunnan, and its streets are busy and lined with many shops. Iron and tin are mined close by and the latter is smelted within the city walls. On May 24 the remaining 8 days of overland journey to Kwangsi was commenced and on May 28 the small city of Puting was reached, after traveling through very hilly or mountainous country with few villages. Inn accommodations are very poor, there being no rooms for travelers, who, therefore, must live in the stables with the horses. Since the construction of the French railway to Yünnanfu, the road has been

TABLE 15.

No.	Name[1]	Date	Lat. North	Long. East
		1916–17	° ′	° ′
1	*Pehtaiho*	Oct. 5–19	39 49.5	119 29
2	*Hankow*	" 30	30 36.4	114 20
3	*Yochow*	Nov. 1–4	29 27.1	113 12
4	*Ichang, A*	" 13–14	30 43.3	111 18
5	Ichang, *B*	" 14, 16	30 42.9	111 18
6	Kiangtsing	" 27	29 11	106 10
7	Sungki	" 28	28 58	105 51
8	Luchow	" 30	28 53.2	105 29
9	Suifu	Dec. 4, 6	28 46.0	104 38
10	Tantow Yun	" 11–12	28 20	104 15
11	Puerhtu	" 12	28 15	104 10
12	Towshakwan	" 14	28 02	104 04
13	Takwan	" 18	27 45	103 50
14	Chaotung Yun	" 21–22	27 21.1	103 45
15	Yichesun	" 26	26 49.6	103 31
16	Tungchwan Yun	" 29	26 25.4	103 17
17	Laitowpo	" 31	26 00.6	103 24
18	Liushuho	Jan. 3	25 38.7	103 15
19	Yangkai	" 4–5	25 25.6	103 07
20	*Yünnanfu, A*	" 10, 12	25 04.2	102 42
21	Yünnanfu, *B*	" 11	25 04.2	102 42
22	Lufenghsien	" 16	25 09.9	102 06
23	Kwangtunghsien	" 19–20	25 10.9	101 48
24	Shakiao	" 22	25 15.1	101 09
25	Yunnanyi	" 24–25	25 25.0	100 41
26	Talifu, *A*	" 30, Feb. 2	25 41.7	100 10
27	Talifu, *B*	Jan. 31–Feb. 2	25 42.7	100 11
28	Taipingpu	" 6–7	25 35.5	99 52
29	Shanyang Yun	" 9–10	25 18.7	99 24
30	Yungchang	" 12	25 07.8	99 11
31	Homushu	" 16	24 59.7	98 50
32	Tengyueh	" 20	25 01.8	98 30
33	Siaosinkai	" 24–25	24 40	97 55
34	Kulonghka	" 27–28	24 24.2	97 37
35	*Bhamo*	Mar. 3, 10	24 15.4	97 14
36	Mengmow	" 16	24 01.5	97 51
37	Mengka	" 19–20	24 15.6	98 28
38	Pingka	" 23	24 21.4	98 56
39	Hankuai Ferry	" 25	24 15.2	99 04
40	Mengtui	" 27–28	23 53.0	98 53
41	Szefangching	Apr. 1–2	23 38.7	99 10
42	Kanfang	" 5–6	23 30.3	99 37
43	Tahuan	" 9	23 19.6	100 05
44	Mengpan	" 12–13	23 07.6	100 22
45	Szemao	" 18–19	22 47.1	100 59
46	Mohei	" 23	23 09.7	101 10
47	Tungkwan Yun	" 25–26	23 16.9	101 24
48	Wana	" 28–29	23 30.3	101 55
49	Lutungpu	" 30, May 2	23 38.8	102 06
50	Linanfu	" 5	23 38.2	102 51
51	Mengtsz, *B*	" 9	23 22.7	103 26
52	*Mengtsz, A*	" 11	23 28.3	103 25
53	Kaihwafu	" 17	23 22	104 12
54	Achikai	" 19–20	23 49.1	104 27
55	Kwangnanfu	" 22–23	24 02.4	104 59
56	Lokung	" 26–27	23 48	105 22
57	Kweitsao	" 29–30	23 38.1	105 47
58	Poseh	June 2–3	23 55.0	106 32
59	Pingma	" 7	23 36.9	107 04
60	Lunganhsien	" 9	23 10.5	107 39
61	Nanning	" 12–13	22 48.1	108 16
62	Wingshun	" 15–16	22 47.2	108 52
63	Kweihsien	" 17, 19	23 06.9	109 35
64	Sünchow	" 20	23 23.4	110 03
65	Mongkong	" 22	23 27.5	110 44
66	Wuchow	" 24	23 28.0	111 17

[1] The provinces in which these stations are located are as follows: No. 1, Chihli; Nos. 2, 4, and 5, Hupeh; No. 3, Hunan; Nos. 6–9, Szechwan; Nos. 10–33, and Nos. 36–57, Yunnan; Nos. 34 and 35, Upper Burma; Nos. 58–66, Kwangsi.

used but little. It is never repaired now and is, therefore, in bad condition, especially in wet weather. The wet season commenced before Kwangnanfu was reached, and this stage of the journey was, therefore, very unpleasant.

From Puting the road followed the left bank of the turbid Shui Chiang River to Kweitsao, a small village from which for the concluding 2 days of the overland journey it led through hilly or mountainous country of red clay to Poyai, where we arrived May 31. Here a boat was hired to take us to the important town of Poseh in Kwangsi. Poseh is the limit of steam navigation on the West River, which is known here as the Yu Kiang. It is a shipping point for hides, aniseed, shellac, and antimony from the district around. The remainder of the route was made in launches and steamers to Canton, which was reached June 26, where the long journey ended and the party was disbanded, Mr. Wu returning to Chungking and the cook to Ichang.

Table 15 (see p. 121) gives list of stations occupied, with dates and geographic positions; for magnetic data, see Table of Results.

Of the 66 magnetic stations occupied, 7 are repeat stations of the Department and 1 a reoccupation of a station of the Indian Magnetic Survey The actual time engaged on field work from Chungking to Canton was 207 days, and the average field time per station about 3.5 days; the total distance traveled is about 3,126 miles, making the average field distance per station a little more than 50 miles, at an average field expense a little less than $28.00

The formation exposed in the Yangtze valley is red sandstone. In Yunnan it seems to be chiefly granite and limestone. In many places the limestone outcrops from a red clay soil. The southeast portion of Yunnan is mostly weathered limestone hills which often rise abruptly out of plains of red clay. The same formation continues to Kweihsien in Kwangsi. In Yunnan the elevations of the magnetic stations above sea-level ranged from 1,100 feet to 8,300 feet at Laitowpo. The magnetic results obtained at Tungkwan, Talifu, and Tengyueh would seem to point to local disturbances at these places.

The Chinese Foreign Office passport, which insured the party full official courtesies and protection and avoided any misunderstanding among the officials as to the nature of the work, was procured through the kind efforts of Dr. Reinsch, the United States Minister at Peking. Most courteous treatment was received from the American and British consuls met en route. Valuable assistance in mail and money matters was generously given by the Postal Commissioners of Yunnan and Kwangsi. Missionaries always extended hospitality to the party. Among those most frequently met were the China Inland Mission, the American Baptist and the United Methodist missionaries. I was most hospitably entertained at various places en route by the officers of the Chinese Customs Service, many of whom took a kindly interest in the work. The British officials at Bhamo in Upper Burma were also most courteous and helpful.

F. Brown, on Magnetic Work in Southeastern China, August to December 1917.

In accordance with instructions dated April 28 and May 21, 1917, I proceeded to organize a party at Canton for the overland journey to Shanghai. The following equipment was carried: theodolite magnetometer No. 9, dip circle No. 206, with needles 1 and 2 of 206, and 5 and 6 of 178; aneroid barometer; boiling-point apparatus; two pocket chronometers; three watches; tripod, observing tent and appurtenances.

Owing to the unsettled condition of South China, great difficulty was experienced in obtaining an interpreter and a cook, but finally Mr. Loh Yui Po, a clerk of the banking department of the Canton Christian College, and a cook named Ah Taam, were engaged. The Chinese launch *Chung Hon* was taken the evening of August 18 for the initial stage of the journey, and Poklo, a small walled city of about 10,000 people, on the East River (Tung Kiang), was reached by noon of the following day. Except for a robber, who got

aboard at Sheklung, only to be forcibly ejected, the trip proved unexciting, in spite of the supposed activity of the pirates who infest this section of the river. The next up-river boat was taken to Waichow, a much larger city, in which one finds electric lights, drug-stores, modern barbers and dentists, and here a transfer was made to another small launch, in which the journey was continued, after an escort of soldiers had joined the boat.

The river flows from the north, winding through low hills of granite and red sandstone, with mountain ranges visible to the west. At intervals of every 3 miles are small white forts, built by the old Manchu government to put down the pirates infesting East River. Since the Revolution, however, they have fallen into disuse and at the present time conditions are as bad as ever.

On the evening of August 21 we arrived at Hoyün, a walled city from which pigs and sugar-cane are exported, and where furniture and buckets are manufactured. A flood in the main streets, with water knee-deep in places, discouraged exploration of the city, and learning that a small launch was leaving next morning for Laolung, 72 miles up river, the opportunity was taken, as further up-river sailings were very uncertain on account of low water. The steamer sailings from Waichow to Hoyün and Laolung can only be depended on during the high-water season in the spring and summer. Above Hoyün the river is from 200 to 300 yards wide, and is full of large sandy shoals, but in places hills close in on either side. Laolung, the head of steam navigation on the Tung Kiang, is a small walled city shut in by low hills, marking the end of the short overland trade route from the upper tributaries of the Han River. The next day a journey of 18 miles was made with chairs and carriers to the large village of Kiling, over a well-paved wide road with frequent large and cool rest-houses. The divide between the two river systems is about 700 feet above sea-level, but grades are easy throughout. Long strings of coolies, chiefly Hakka women, were met, carrying paper, cloth, and crockery to Laolung to be shipped to the Canton markets. Kiling marks the head of navigation of the Mei Kiang, the main western tributary of the Han River, also known as the Changlok Ho in its upper reaches. A boat was hired on the evening of arrival (August 24) and a pleasant journey down river to Kaying was completed on August 26, advantage being taken of the bright moonlight to travel also by night. The native boats are wide and very roomy, drawing about one foot of water. Near Kiling the river is barely 100 feet wide, but widens to about 600 feet at Hingninghsien and flows through pleasant hilly country, wooded in places with fir and clumps of bamboo. Kaying is the chief city of the Hakka country, and is a great educational center. It has electric light, drug-stores, dentists' shops, and photographers. Cloth and some crockery are manufactured, but the city is of most importance as a transshipping place for tea and tobacco. The people are very enlightened, almost every family having some of its members abroad in America, the Straits Settlements, Australia, or elsewhere. The Hakka men are more adapted for merchants and officials than for work requiring manual labor, and thus it is that women do most of the labor in the fields and also act as carriers. Transport charges are comparatively high in this district, each coolie receiving 50 to 80 cents per day.

The river trip of 33 miles to Tsungkow by launch takes 4 hours and is full of interest. The stream has cut through the reddish hills, in some places with a channel only 100 feet wide, and rapids and rocks are numerous. Below Tsungkow the river scenery is very pretty, grassy and wooded hills rising steeply from the water's edge. The river, nearly 100 yards wide, was shallow, with a very strong current. On August 29 we reached Samhopa, 23 miles down stream, situated near the junction of three rivers, and formerly of great importance as a transshipping point for all produce from Fukien. Since the opening of Swatow on the coast as a treaty port, Samhopa has gradually declined, till today it is little more than a long business street on the river bank, backed by the old city, whose walls now inclose residences, ponds, gardens, and ruins. The houses on the water front

have three or four stories, which is quite unusual for China, but which is necessary in this case on account of the big floods. The people then move from floor to floor as the waters rise. On August 31, the 42-mile trip up the Ten Kiang was made to Shihsiapa, passing through Tapuhsien, a walled city about 25 miles above Samhopa. Tapuhsien is a shipping place for tobacco and paper, and overland travelers should disembark here for Yungting and Lungyenchow, instead of at Shihsiapa, to avoid the exorbitant carrier charges. Shihsiapa is built on both sides of the lower end of a narrow rocky gorge full of rocks and rapids. It marks the end of steam navigation. Tingchowfu, about 150 miles up river, can be reached by small boat from this point.

After considerable trouble with carriers, an overland stage of 14 miles was made to Yungting, a walled city of no importance, where no carriers could be obtained, and the next stage was therefore made by canoe up the Yungting River. Kanshih, a large market village 23 miles north, was reached the following night, after an interesting but cramped trip through a beautiful country of hills and gorges covered with woods and scrub. Thence an overland stage of 17 miles placed the party at Lungyenchow. The country is so gently undulating that the divide between the Han and Min river systems is not readily recognized. Tobacco is largely cultivated in this district, where the very large four-story houses, built of mud plastered white on the outside, are a prominent feature. The walls of these houses are loop-holed and from a distance the buildings look like large barracks. They were used as places of refuge in less settled times, not very long ago.

Travel was now irksome. Besides the hot weather and uncomfortable inns, the carriers were very unsatisfactory, each man insisting on carrying a load of at least 100 catties (133 pounds), which made progress very slow. None of the party spoke the local dialect, and had it not been for our knowledge of Mandarin, trouble would have occurred. Lungyenchow is a quiet city about half a mile square, walled in, and built at the junction of two mountain streams, in a large valley between mountain ranges. It has but one narrow crooked main street and a few shops. Tobacco and paper are sent south to Tapuhsien and coal is mined in the district. It was entirely due to the good offices of Mr. Chan, the Chinese pastor of the London Mission chapel, that coolies were procured for the next stage of the journey to Yenpingfu.

An overland journey of 70 miles in 4 days took us to Siaotao, the head of boat navigation of the Yung or Tashi River. On the second day of the journey the country became very mountainous and lonely, with no inns or villages. After leaving the large village of Paisha (27 miles), the road dwindles to a small foot track which follows up a very fine gorge, where the scenery is magnificent and suggestive of the Yangtze gorges. Further on it climbs over wooded mountains, leading through small hamlets and villages, half in ruins, until, about 12 miles from Siaotao, it attains an elevation of 3,800 feet on a rocky pass, from which there is a glorious view of the surrounding mountains. This was by far the most interesting stage of the overland trip to Shanghai, though the carriers and chairmen were not backward in expressing their opinion of the roughness of the path and the steepness of the tracks. Each man carried a small sack of rice, and every few hours the caravan would halt near some stream and boil some rice and tea. Wherever the road was particularly bad and steep, these halts became annoyingly frequent, and progress was accordingly slow.

Siaotao was reached September 9, and the journey down river was begun in a small gondola-like canoe, in which one had to sit still to avoid capsizing. The trip to Yungan Fu proved very exciting The canoe struck rocks three times in the rapids and almost overturned. The river is narrow, flowing between wooded hills, and is a succession of rapids and races. In one place it is particularly dangerous and passengers are requested to walk along the bank. Yungan Fu, a walled city of some importance, is situated at

the junction of two rivers, and marks the end of the native cargo-boat traffic. There a large cargo boat, laden with paper, dried fish, and bamboo rope, was boarded for the final stage of the journey to Yenpingfu, but in attempting the large rapid just below the town, she was dashed onto a partly submerged rock, and after being almost overturned, was swept on by the rush of waters, with the bottom boards stove in. The crew hurriedly ran her ashore where the cargo was transferred to a salvage boat sent down from the city. As extensive repairs were needed, the trip was not resumed until the following afternoon, Kungchwan being reached by evening. This section of the river is very attractive, bare red cliffs of sandstone rising abruptly from the water's edge, with wooded hills and mountains on every hand. The large walled city of Shahsien was reached September 14, where a smaller boat was hired, in which we arrived at Yenpingfu early the following morning. From Yungan down, the river had been full of dangerous rapids and races, and many boats are wrecked and lives lost in the worst of them.

Yenpingfu, like Rome, is built on seven hills, though the chief business center runs along the river bank. It is interesting as an old "Fu" city, but is of no special importance except as a shipping point for local products. Red lacquer-ware is made in the city.

From Canton to this point (August 18 to September 15) the weather had been bright and hot, with occasional short wet intervals and thunderstorms. The people appear to be very enlightened, friendly, and accustomed to foreigners, thanks to missionary activity. Generally speaking, carriers are expensive and unsatisfactory. Most of the traffic is on the rivers, and the traveler would do well to avoid overland journeys except those across divides or in the mountains. Cantonese currency is in use as far as Lungyenchow, beyond which assorted chopped dollars and Hupeh small coins are current. Supplies can be obtained everywhere, except between Lungyenchow and Siaotao. Chickens, eggs, rice, flour, vegetables, and fruit are for sale at most villages, while at the larger towns tinned milk, fruits, biscuits, and even meat can be procured. The various dialects encountered are the chief difficulty of the traveler, and are often the cause of loss of time and money. Cantonese is of little use beyond Laolung and a knowledge of Hakka would not take one far beyond Kaying. Mandarin is undoubtedly the most useful Chinese to speak, and in most places it was found that the better classes of merchants and gentry had a knowledge of it.

From Yenpingfu to Nanchang the party followed the well-known main route via the Tiu River to Kienchangfu, and thence north down the Fu River to the capital. The trip to Shaowu, 120 miles, lasted 6 days, and was made in a small boat locally termed a "min chiang." Above Yangkow the rapids are less dangerous and the river narrows often to 100 or 200 feet. The natives fish from small bamboo rafts with cormorants. Villages are not numerous and there is considerable waste land. Tea is cultivated on the hill slopes and rice in the valleys. Shaowu is an old "Fu" city, which has never recovered from the Taiping rebellion, when it was sacked and two-thirds of its population killed. The city walls surround residences and ruins, the chief business streets being outside the city. Paper is a local industry, and rice is exported down river, though there is but one crop a year. Winter crops are beans, peas, and wheat.

From here an overland stage of about 70 miles via the busy walled city of Kwangtseh was made to Chikai, a village at the head of small-boat navigation on a small river joining the Fu River near Kienchangfu. On the afternoon of September 26 the province of Kiangsi was entered at the village of Shankwan, situated among small hills at an elevation of 1,000 feet above sea-level. The road to Chikai is paved throughout, and is in fair condition in spite of the wheelbarrow traffic. Villages and hamlets are numerous, though none appears very prosperous, the houses being poor structures of wood

and mud. The country is hilly, but though the slopes are steep, the hills are not high, and the road undulates gently over them. Kienchangfu, a large walled city with a population of about 30,000 people, was reached from Chikai by small boat on September 28. A massive bridge spans the river, which is about one-fourth mile wide, though the actual channel is considerably restricted by shallows and sandbanks. The city is a shipping place for local products and is famous for its medicines. Oranges and peanuts, and large rafts of timber come from Nanfeng and other places further up river.

We continued by small boat from Kienchangfu to Fuchow, a busy walled city of 60,000 population, 50 miles downstream to the northwest. An unpleasant feature of this stage was a cooking fire that successfully smoked everybody out of the interior of the boat whenever it was lighted. Compared with the Min River and its branches, the Fu is very uninteresting, flowing through a sandy bed about half a mile wide, with very little current. The country is generally flat and featureless, except for some abrupt red sandstone hills and cliffs near Kienchangfu. The manufacture of dye is a local industry of this district, where the banks of the river are often lined with large tubs in which the indigo plant is soaked and the blue dye extracted. We started in the evening of October 2 for Nanchang by small boat. A strong head wind and wet weather delayed the boat journey to Siapu, a market village and transshipping point about 50 miles down stream, which was not reached till the night of October 4. Thence a wheelbarrow journey of 40 li (14 miles) across an intensely cultivated plain was made to Nanchang, a large city of 750,000, the provincial capital and mart town of Kiangsi. It is connected by rail and by steamer with Kiukiang, a treaty port on the Yangtze, while, in the high-water season, small launches ascend the Kan River to Kanchow. The journey from Yenpingfu to Nanchang lasted from September 18 to October 5, and presented no special difficulties. Mandarin is usually understood, but the boat people and country folk have a dialect quite different. The people are friendly and enlightened, and supplies are obtainable in the majority of towns. Boats should be used as far as possible, as carriers are expensive and unsatisfactory.

The journey from Nanchang to Hangchow across Kiangsi and Chekiang provinces via Kwangsinfu proved to be a simple undertaking, involving only three days of actual overland travel. The route follows up the Kwangsin River to Yushan and thence crosses a low divide to Changshan, the head of boat nagivation on the Kü Ho. During the high-water season in the spring and summer, a launch can be taken to Anjen and the journey to Kwangsinfu continued up river by small boat via Iyang. Iyang may also be reached from Nanchang by a 5-day overland trip with carriers and wheelbarrows, but I chose a route via Jaochow which gave a better distribution of stations, was just as quick, and involved only 2 days of wheelbarrow travel.

On October 8 the daily launch was boarded for Jaochow, a large city near the eastern shores of the Poyang Lake. The passage usually takes about 8 hours, but by evening only half the distance had been covered, as the boat was tied up every few hours alongside the bank in order to draw the fires and cool the engines and boiler. The following morning, soon after entering the lake, the launch ran hard and fast on a sandbank, and defied all efforts to shift her till the afternoon, when a number of fishermen were signaled to assist. Jaochow was eventually reached October 9, after a delay of 25 hours on a trip supposed to last but 8. Jaochow, now a long main-street following the river bank, its old city walls inclosing fields, ruins, and residences, suffered considerably during the Taiping Rebellion.

A start was made the same evening by small boat for Shihchenkai, 70 li to the east up the Nan Kiang, and by all-night travel the little town was reached early the following morning, October 11, where five wheelbarrows were hired to transport the baggage and Mr. Loh and the cook to Iyang Ki, 50 miles to the southeast, and a carrier engaged

for the instruments, which, owing to the uneven roads and constant bumping, could not be carried on the barrows. Wheelbarrow travel to the European is the height of discomfort, even when properly padded and propped up by baskets, but one sees Chinese gentlemen riding for miles, one on each side of the barrow, a framework carrying two seats, built around a large wheel A well-dressed Chinese lady may often be seen in half of the barrow, with a trussed-up pig, its snout pointing to the sky, in the other half. The porker is never backward in voicing his complaints when the road is particularly rough, and the hideous squeak of the barrow is accompanied by a series of grunts. The average European prefers to walk, but there is no choice left to a magnetic observer, loaded with chronometers and watches requiring careful handling. On the morning of the second day we crossed the Ta Ling Shan, a range of low but steep hills, by an easy pass up a long valley, at an elevation of about 600 feet above sea-level. From Shihchenkai to Iyang the road generally is good, with a stone track for pedestrians alongside an earth track for barrows.

From Iyang, travel was resumed in a small boat 23 miles up river to Hokow, where another boat was taken, and late in the evening of October 14, the journey of 27 miles was completed to Kwangsinfu, an old "Fu" city, large and busy, exporting country produce. Its inhabitants are not quite friendly, but previous to Boxer Year (1900) it was their boast that no foreigner had entered their gates. The Kwangsin River is more interesting than the Fu River, and above Iyang Ki it varies in width from 100 to 300 yards, flowing through gently undulating country, with bare red cliff-like hills of sandstone occurring here and there. Mountain ranges are visible to the north and south. Large weirs are built across the river every few miles, with narrow channels left open for boat traffic. The water is thus kept in the upper reaches, and many shallow stony rapids which otherwise would be impassable for boats are made navigable. For the remaining stage up river, 33 miles, another boat was hired and Yüshan was reached on the evening of October 17. Small bamboo rafts are used on this stretch and fishing with cormorants was often seen. The town is quite extensive, and marks the end of the short overland trade route from the headwaters of the Kü River in Chekiang. With the assistance of the mission station, coolies were hired for the 27 miles overland, which was finished October 18. The road is paved throughout and undulates gently through low grassy hills of red and grey rock. Villages and hamlets are numerous and there is considerable coolie, wheelbarrow, and mule traffic.

The journey down river was commenced in a small boat, to Chüchowfu, where observations were made October 22 in the Martyrs' Cemetery in the city, a pretty spot where lie the remains of the English and American missionaries murdered during Boxer Year. Chüchowfu is a large walled city with a population of about 80,000 people, the streets are fairly wide and clean, and are lined with good shops and stores. Above Chüchowfu the river flows through low hills and undulating farming country producing rice, barley, fruit, and sugar cane. Rapids are numerous, but not dangerous. At noon on October 25, Tungkwan, a suburb of Yenchow, was reached, and a halt made to change the police escort which had been imposed upon the party ever since reaching Changshan Che. At this point the Singan Kiang flows in from the west, and the combined streams form the Tsien Tang Kiang, which below Yenchow enters a gorge. On both banks are narrow strips of cultivated land producing millet, maize, barley, potatoes, and vegetables. After a stop at Tunglu, we went by launch 60 miles down river to the provincial capital, Hanchow, a large up-to-date city connected by railway with Shanghai. It is famous throughout China for its beautiful West Lake, where the natural beauties of a large sheet of water, surrounded by wooded hills and islets, have been enhanced by the picturesque grouping of temples, flower gardens, and pagodas. After a call at Zikawei Observatory, where a cordial welcome was given by

Monsieur Gautier, the director, the party went by rail to Lukiapang to make intercomparisons with the observatory instruments. I was engaged in this work from October 31 to November 3, some delay being caused by the wet windy weather which prevailed.

Returning to Shanghai, we began the return to Canton, November 5, when we boarded the *Hsin Peking* for Ningpo. On November 8 the steamer *Poochi* was boarded for Wenchow, where we arrived Saturday, November 10. Having procured a guide who could speak both Mandarin and the local dialects, I started south on November 12, taking a launch to Juian, a walled city 23 miles southwest by canal. Thence, having crossed the Feiyün Kiang, a strong tidal river, at this point, I hired two small boats to take us to Pingyang, 30 li (10.7 miles) distant by canal. Linki, about 20 miles distant, was made by canal boat, with a 3-mile walk between the two canal systems at Shiae Ko Du. This section of the country consists of plains broken by steep-sided rocky hills and ranges. It is intersected by numerous canals and waterways, and produces rice and sweet potatoes. In connection with the local magnetic disturbance, observed at Linki on November 14, it might be noted that the formation of the district is igneous rock. An overland journey of 80 li (28.6 miles) by carriers was made to Futing, a walled city situated near the head of an arm of the sea. The road gradually ascends a long valley between rocky bare hills to the Fukien border, where the gate is found at an elevation of about 1,000 feet above sea-level. From here on, the country continued either very hilly or mountainous. On November 16 a distance of 50 li (17.8 miles) was made to Pailin, a large market village producing tea and dried sea-products. The mountain scenery for 80 li (28.6 miles) beyond Pailin is very beautiful. Rice, turnips, and sweet potatoes are grown in the valleys, but the hillsides are devoted to tea and tea-oil trees. The mountain sides are clothed with good timber (fir, cedar, spruce, and deciduous trees), besides bushes and scrub. Waterfalls and streams are numerous, tumbling from crags and ravines of dark-brown igneous rock. The road over the mountains attained a height of 1,500 feet before descending steeply to the plain on which Funingfu is situated. Funingfu is built along the base of some steep wooded hills, about 5 miles from the head of Funing Bay, with an estimated population of 15,000. Tea, tea-oil, sugar, and sweet potatoes are its chief exports. Large droves of goats are driven through annually on their way to Foochow for slaughter. The port of Funingfu is a little village called Yentien, 40 li (14.3 miles) south at the head of an inlet of the sea. The guide from Wenchow was paid off at this point and sent back, as he could not understand the ever-changing dialect. By courtesy of the Church Missionary Society, the journey to the treaty port of Santuao was made in the mission junk, a clean, roomy craft named the *T. C. D.* (Trinity College, Dublin). A sail of about 3½ hours sufficed to reach Santuao.

The trip round the coast from here to Foochow takes about 8 hours by steamer, but as there was no vessel due for at least 5 days, it was decided to proceed overland. On the night of November 21 the crossing to Feiluan was made in the custom-house boat and next morning a caravan of coolies was hired for the 50-mile journey to Kwantow, near the mouth of the Min River, from which place a launch runs daily to Foochow, 25 miles farther inland. On November 23 a long stage of 100 li (35.7 miles) was made to Lienkong, where the party arrived long after dark. The slowest coolies did not arrive till 10 o'clock and were urged along to prevent them passing the night at some wayside inn. The city gates were closed, but an entry was effected by scaling a breach in the walls, the loads being passed up in pieces. The road traveled runs over hilly country after crossing a pass at an elevation of 850 feet. The journey from Wenchow to Foochow, a distance of 280 miles, lasted from November 12 to November 24, inclusive of delays amounting to 3½ days for observations. The weather remained fine and

bright throughout, with warm days and cool nights (temperature often as low as 40° F.). Between Wenchow and Funingfu supplies are scarce and biscuits and tinned goods should be carried; a guide and interpreter is also necessary for this section of the trip, and a knowledge of Mandarin is very useful.

As the next coastal steamer to Amoy was not leaving until December 2, a trip was made to Shuikow Fu, about 50 miles up the Min River, returning December 1 to Foochow. Steam navigation on the Min ends here, and cargo for the interior is transferred to small boats.

Amoy was reached on the morning of December 3, and on December 5 a pleasant trip was made through sheltered waters about 40 miles up the coast to Anhai, which is situated some distance up a creek and can not be reached at low water. Arriving here at noon, coolies were at once hired with the help of the local pastor, and the overland stage commenced, Chüanchowfu being reached after about 6 hours of steady walking. It being necessary to take passage on the next steamer south from Amoy, the time at Chüanchowfu was short, and the return journey to Anhai began December 6, arriving at Amoy on the afternoon of the following day, thus allowing the party an hour in which to join the steamer *Haitan*. The treaty port of Swatow was reached at 7 a. m. on December 8, and the magnetic station of 1906 was at once reoccupied.

There was fighting near Chaochowfu, about 25 miles to the north, and as both trains and launches were no longer running, it was deemed advisable to forego the repeat observations. As there seemed to be trouble along the whole coast southward of Swatow, the party rejoined the *Haitan* the same afternoon, and reached Hong Kong on Sunday morning, December 9. The night boat to Canton was then boarded, and the party reported at the Canton Christian College the following morning, thus ending a very pleasant trip of about 3,000 miles, lasting almost 4 months.

After a short stay in Canton, where the necessary instrument comparisons were made, passage was taken for Washington, where I arrived early in February, 1918.

The party left Canton on the night of August 18 and returned the morning of December 10, an interval of 114 days. The total distance traveled was 3,161 miles, which gives an average distance of 83 miles between stations. The total field expenses from August 18 to December 10 was equivalent to about $830.

The country traversed was with few exceptions hilly or mountainous, but the observations at all stations from Canton to Shanghai give no indications of local disturbance at any point. From Ningpo southward along the whole coast to Canton, the country is very mountainous and the rock is chiefly granite. There is local disturbance probably at many places, especially in the section between Wenchow and Funingfu.

No opposition was encountered on the expedition, either from the people or the officials, who, even in the mountain regions, appeared to be quite enlightened, with no superstitious fears of the instruments or observations. The coastal provinces of Kwangtung and Fukien have been the scene of missionary work for about 60 years, and practically every village of any size has its own little chapel or church, where the European is sure of a welcome and assistance if necessary.

The success of the expedition was largely due to the generous aid and advice given by the foreign missionaries met during the campaign. It was also due in a large measure to the Chinese Foreign Office passport obtained through the kind efforts of Dr. Reinsch, United States Minister, which explained in full the object of the observations. Effective Assistance and cooperation were rendered by Father H. Gautier of Zikawei Observatory, Father de Moidrey, director of Lukiapang Observatory, and Mr. Graybill of Canton Christian College. Various courtesies were extended by Mr. Ollington, postal commissioner of Chekiang; Mr. E. Alabaster, commissioner of customs at Hangchow; Mr. F. Carey, commissioner of customs at Santuao; and Mr. Little, British consul at Amoy.

The following table shows the magnetic stations, their geographic positions, and the dates of occupation. For magnetic elements, see Table of Results.

TABLE 16.

No.	Name [1]	Date	Lat. North		Long. East	
		1917	°	′	°	′
1	*Canton, B*s	July 2–3	23	05.8	113	18
2	Poklo	Aug. 19–20	23	09.6	114	20
3	Laolung	" 23	24	07.0	115	16
4	Kaying	" 27	24	21.1	116	08
5	Tsungkow	" 28	24	29.8	116	25
6	Samhopa	" 29–30	24	24.7	116	34
7	Yungting	Sep. 1–2	24	43.1	116	44
8	Lungenchow	" 5	25	06.9	117	02
9	Siukiu	" 7–8	25	26.4	117	10
10	Siaotao	" 10	25	44.7	117	06
11	Yungan Fu	" 12	25	59.3	117	20
12	Yenpingfu	" 15, 17	26	39.1	118	08
13	Shuikowchai	" 21	26	59.4	117	50
14	Shaowu	" 24	27	21.2	117	28
15	Kienchangfu	" 28	27	33.1	116	36
16	Fuchow Ki	Oct. 1–2	28	01.0	116	18
17	*Nanchang, A*	" 5–6	28	42.4	115	51
18	Nanchang, *B*	" 6	28	42.2	115	51
19	Jaochow	" 10	29	00.1	116	38
20	Iyang Ki	" 13	28	25.6	117	24
21	Kwangsinfu	" 15–16	28	26.3	117	56
22	Changshan Che	" 19	28	53.4	118	28
23	Chüchowfu	" 22	28	57.2	118	51
24	Chushangpu	" 24	29	17.7	119	29
25	Tunglu	" 26	29	46.0	119	39
26	*Hangchow*	" 29	30	18.0	120	08
27	Lukiapang	" 31, Nov. 3	31	19.0	121	02
28	*Ningpo*	" 7	29	53.5	121	33
29	Wenchow	" 10	28	00.9	120	38
30	Linki	" 14	27	29.8	120	23
31	Pailin	" 16–17	27	11.8	120	10
32	Funingfu	" 19	26	53.0	120	00
33	Santuao	" 21	26	37.7	119	40
34	Loyüanhsien	" 22	26	30.9	119	29
35	*Foochow*	" 26, 28	26	02.1	119	19
36	Shuikow Fu	" 30	26	21.7	118	45
37	*Amoy*	Dec. 3	24	26.2	118	04
38	Chüanchowfu	" 6	24	54.6	118	37
39	*Swatow*	" 8	23	21.2	116	40

[1] The stations are located in the following provinces: Nos. 1 to 6 and 39, Kwangtung; Nos. 8 to 14 and 34 to 38, Fukien; Nos. 15 to 21, Kiangsi; Nos. 22 to 26 and 28 to 30, Chekiang; No. 27, Kiangsu.

On the route followed, accommodation could always be procured at inns or villages. A folding camp-bed with three blankets, a mosquito net, and a folding camp-stool should be carried. Kerosene is obtainable at most places, hence a good lamp may be carried for night work at inns. An electric torch with refill batteries is very useful for star work and for use in Chinese inns and towns. Tinned milk is for sale at most cities, as also various kinds of cakes and sweetmeats. Tea, cocoa, jam, tinned meats, and breakfast foods should be carried.

F. BROWN, ON MAGNETIC WORK IN CAMEROUN AND FRENCH EQUATORIAL AFRICA, MAY 1919 TO JANUARY 1920.

In accordance with instructions received at London, dated March 7, 1919, I arranged for passage from Liverpool to Douala.

The following instrumental outfit was taken: theodolite-magnetometer No. 13 and trunk case; dip circle No. 177 in trunk case, with dip needles Nos. 13X, 14X, 15X, and

Typical Views of Magnetic Expeditions in Australia.

1. Camp, Wiluna, Western Australia.
2. Landing, Roper River Mission Station, Northern Territory.
3. C. I. W. caravan, Eucolo Creek, South Australia.
4. Boundary rider's hut, rabbit-proof fence, Western Australia.
5. Kunningarra Range near No. 48 Well (typical hills of interior), Western Australia.
6. Magnetic Island near Townsville, Queensland.

16X; two tripods; pocket chronometer and watch; small box-chronometer; observing tent complete with appurtenances; aneroid barometer; and kodak.

The voyage from Liverpool to Douala was made in the steamer *Chama* of the Elder Dempster Line, between April 9 and May 2. There being no convenient steamer connection from Douala to either Principe Island or Libreville, both of which were on the line of totality of the eclipse of May 29, 1919, it was decided to make the eclipse observations at Campo, in the southwest corner of the Cameroun, about 120 miles north of the line of totality.

His Excellency, the Governor at Douala, M. Carde, very kindly arranged to send the small coastal steamer *Fullah* to Campo in order to give me the necessary time required in the preparation for the eclipse work. While awaiting the steamer, a trip was made along the northern railway which terminates at Nkongsamba, 100 miles to the north, and also to Edea on the Midland Railway, there being two trains weekly to these points. The *Fullah* left Douala in the afternoon of May 22 and arrived at Campo the following day at noon, a stay being made till June 5 for eclipse observations. Lieutenant Petit, Chief of the Subdivision, Campo, kindly provided a squad of native troops and a gang of prisoners to erect a non-magnetic hut under my directions. A hut was used in preference to a tent, in which observations would have been impossible during the heavy storms of the tornado season. The day of the eclipse was very fine excepting the afternoon, when clouds obscured the Sun about half an hour after the maximum phase had occurred.

During the war, Campo was bombarded by the British and the cement buildings of the traders were razed to the ground. Today the place consists of a few trenches and ruins, with the houses of the French post built by natives on the bare sand. Campo is perhaps interesting because of its internment camp, which serves as the last home of many chiefs and sultans of the northern portion of Cameroun who give trouble to the government. When the Sun was almost eclipsed, the Sultan of Tibati arrived in state, with his wives and dependents, and entered the internment camp, taking the eclipse of the Sun as an omen of his eclipse as the Sultan of Tibati.

On June 5 the long overland journey to Lake Tchad, at the northern extremity of the Cameroun, was commenced with a caravan of black carriers and a hammock carried by four men. A march of 3 days along the coast put the party at Kribi. Along the greater portion of the route there is no track in the dense forest, and it is therefore necessary to walk along the sandy shore. In former days Kribi was a flourishing port, where traders bought rubber, palm-oil kernels, and ivory from the coast natives who acted as middlemen between the interior tribes and the white men. Then came the penetration into the interior and the building of the Midland Railway from Douala, but though some trade was diverted to Edea, Kribi owes its decline to the war. Today it has the appearance of a deserted city, the "factories" (trading posts) standing empty, and most of the other buildings being unoccupied.

From Kribi a well-made motor road leads to Yaounde, 285 kilometers distant, or 12 days' march by carriers. I followed a more southern route, passing by Efulen and Ebolowa to Olama, which is on the main Kribi-Yaounde road. At each of these three places there are stations of the American Presbyterian Mission, which is working among a large tribe called the Bulu. The missionaries have done a considerable amount of work in the region, building roads, founding hospitals and churches, organizing village schools, and teaching the natives simple trades at the industrial school in Ebolowa. During the 6 days' march from the coast to Ebolowa, we followed a good road leading through dense tropical forest, with continuous chains of villages throughout its length. The Bulu people are hospitable and the traveler is constantly offered presents of chickens, eggs, and a considerable variety of fruit. From Ebolowa to Olama one passes out of

the Bulu territory and enters the country of the Yaounde tribes. The country is thickly forested and very hilly, but the path is good enough for a bicycle.

A march of 3 days over hilly but populous country was next made to Yaounde, the old German military capital of the Cameroun. It is pleasantly situated on several steep hills, at an altitude of 2,500 feet above sea-level. It is much cooler and less humid than the damp coastal towns. The mean temperature for the year is only 24° C., and during certain seasons the night temperatures are as low as 17° C. In addition to the government post there are several British trading firms and also some French "factories." While here, news was received of the signing of the Peace Treaty, and the Governor having proclaimed a general holiday, the 30th of June was given over to the peace festivities. Sports were held for the natives during the afternoon and all the local chiefs arrived with their followers, the latter forming into groups of dancers.

The work at Yaounde being completed July 1, the party bade farewell on the following day to the comparatively civilized coastal area, and set out across central Cameroun for Yoko, a French government post 10 days' travel northeast. Just north of Yaounde the thick tropical forest ends abruptly, the nature of the country changing to low rolling hills covered with open bush and scrub. In the dry season this is splendid game country, the grass being burnt off each year by the natives; during the wet season, however (May to October), the rank grass 10 to 15 feet high effectively hides the antelope, swine, and buffalo.

A good motor road leads to the Sanaga River, 3 days' march north of Yaounde; beyond, the type of village suddenly changes, the huts being round, with conical roofs (see view 3 of Plate 3), instead of the familiar rectangular pent-roofed huts of bark and bamboo of the forest region. Two days again beyond the Sanaga River, which the natives refer to as the "Big Water" (it is 200 to 300 yards wide), is the important native town of Nghila, where there was formerly a mission station. The country here is less populous, the villages are often separated by several hours' march, and the road grows worse, the chief difficulties being at the small rivers and streams which often have steep banks of red laterite clay that becomes very slippery after a rain. The road, as elsewhere in the Cameroun, is divided into stages of 20 to 35 kilometers (12 to 22 miles). At the end of every stage, one finds a small camp, maintained by the local chief, containing a rest house for the white man, a kitchen hut, and other huts for the carriers. On arrival the chief comes to salute the European, usually bringing a chicken, some eggs, and fruit. Food for the carriers is supplied in the afternoon or evening, consisting of cooked plantain or cassava or boiled maize flour, depending on the locality. Carriers march at 5 kilometers an hour, and as the average government stage is 25 kilometers, the daily march averages 5 to 6 hours. Early morning starts at 5 or 6 a.m. are preferable. The march can then be finished by noon, avoiding the heat of the afternoon, and also the heavy thunderstorms in the wet season, which generally commence at 2 or 3 p.m. Loads are usually carried on the head on a small pillow made by twisting grass or reeds together. A load must not exceed 30 kilos (about 60 lbs.), and each carrier is paid 1.25 francs per day, this amount including payment for his food. With a stage from 25 to 30 kilometers, it is quite easy to arrive at the night stop by noon, thus leaving the afternoon and evening free for observations. For this reason no delays for observations were made except at the government posts after marches of 8 to 12 days. Yoko was reached on the morning of July 11, where I was hospitably entertained at the government post, which is built in the form of a fort and most pleasantly situated, overlooking the plain of the Sanaga River to the south. Except for the afternoon storms, the weather was ideal, with cloudy mornings and temperatures of 17° C. at 6 a.m.

From Yoko the main road extends first due north to Tibati, a march of 5 days, and thence turns northeast to Ngaoundere, an important town in central Cameroun. The

first 3 days from Yoko are very hilly, but except for the steep descents into the stream bottoms, the road is good. The small rivers are heavily wooded, but otherwise the country is covered only with low timber and bushes, of no use commercially. Though the country is peopled by the Mbum tribe, one finds that the village chiefs are usually Fulbé or of that stock, the descendants of the warlike race which oppressed the pagan tribes during the stormy times before the European occupation of Africa. Tibati is a large native town of several thousand inhabitants, and is ruled by a sultan of some importance, who lives in a palace of round huts surrounded by high mud walls. The post is situated on a hill overlooking a large lake, but at present it is not occupied by a European.

From Tibati a march of 7 days puts the traveler at Ngaoundere. The road is undulating or hilly, and swampy where it leads over flats of bare laterite rock, lightly covered with short sweet-smelling grass. The country is not populous, and for several days no villages were seen on the road. The rest camps, however, are placed near villages in the bush which supply food for the white man and his carriers. After leaving Tibati fruit is unobtainable, but milk and butter can be obtained at some camps.

Ngaoundere was entered on the morning of July 25, and observations were made the same day and also on July 26 at the French government post, which is being built on a hillside overlooking the native town. This town has a population of 15,000, of which 4,000 are men; thus it ranks second in the Cameroun, being surpassed only by Maroua in the Lake Tchad region. It is surrounded by a dilapidated mud wall of about 6 miles, and consists of a series of compounds of huts surrounded by walls of mud or matting. To cross from one part of the town to the other it is necessary, except on the main streets, to follow the narrow winding alleys between these compounds. The rest-house for travelers is a large mud structure opposite the market, where it is besieged by the swarms of flies and numerous crows and vultures that infest the busy spot. A daily market is held and the European can obtain a fine variety of food, including chickens, eggs, beef, mutton, milk, butter, honey, rice, maize, potatoes, onion, etc., but no fruit. Before leaving, a visit was paid to the sultan, who lives in a round mud hut inside a high mud-walled inclosure. He is a man of some importance, and during the interview the natives acting as interpreters remained crouched upon the ground, speaking in low humble tones, and not daring to look at the "Great Chief." On Sunday the sultan rode out in state, surrounded by his archers and spearmen. The streets were filled with yelling horsemen, galloping up and down in their colored and picturesque garments and brandishing their quaint weapons. Ngaoundere is approximately the central town of the Cameroun, and one finds roads and native tracks leading in all directions. It is noted for its cattle, which are exported to the coast and even as far south as Ouesso on the Sanga River. The elevation is approximately 3,800 feet.

From Ngaoundere to Garoua the party traveled by way of Rei Bouba, a large native town 8 days' march to the northeast. The first day's march led over open grass steppes, and crossed the Wina, the headwaters of the Western Logone River, by a peculiar hanging bridge of vines and creepers. The following 5 days led through mountainous country clothed in thick bush, with very few villages on the road. The night of August 2 was spent at a small rest camp in the mountains at an elevation of 4,000 feet, but from that point the road gradually descends to the plain of the Rei River, which is but 700 feet above sea-level.

Two days before reaching Rei Bouba the party met one of the sultan's head men bringing ten carriers with presents of food, including several loads of rice, pots of native honey, food for the carriers, and a supply of butter. The town was reached August 6. The sultan's body-guard of ten archers and ten mounted spearmen, clad in multi-colored uniforms, were waiting outside the city gate to salute the party and to escort them to

the rest-house near the palace. On my arrival the sultan sent a cow, pots of honey, and several calabashes of butter for me and an enormous quantity of food for the carriers. One can not refuse these presents without giving offense, but at the same time one is expected to give a suitable present in return. Europeans nowadays do not carry actual presents, but pay a sum of money equivalent to the food given by the sultan. With the abundant supplies given, of which only one-quarter possibly might be used, a visit to one of these towns proves rather expensive.

From Rei Bouba the journey was continued to Garoua in two small canoes from August 8 to 11. The trip can be made in two days under ordinary conditions, but heavy storms on two occasions and the necessary halt for observations at Lagdo delayed the party. At a half day's paddle from the town the Rei empties into the Benue, an important tributary of the Niger. The country is flat and uninteresting, except at Lagdo, where the river flows through a pretty gorge.

Garoua, which was defended by the Germans during the late war until the allied forces were able to shell the position from a near-by range of hills, is an important post, marking the head of steam navigation on the Benue River. During the high-water season, from July or August to December, the paddle steamers of the Niger Company ascend from Burutu on the coast, with stores and supplies for the ensuing year. The exports are chiefly rubber, hides, and a small quantity of ivory. In ordinary times the traveler can secure supplies at the Niger Company's factory, but owing to the war and the fact that the first boat of the season had not arrived, a few tins of biscuits, some sugar, and tinned fish were all that remained in the way of tinned goods. An ample supply of flour and kerosene, however, was obtained here, for it was probable that the French factory at Fort Lamy would have even less provisions than at Garoua.

In the dry season the main road is used to Fort Lamy, passing by Maroua, which is 8 days' march from Garoua. Fort Lamy is another 7 days beyond. Between August and November, however, the road beyond Maroua is impassable in the swamps, and the French officials use the route passing by Lere to Bongor on the Logone River, which is 12 days' march to the northeast, descending the river from that point either by steamer or canoe.

In order to obtain the best possible distribution of stations, I followed the main route to Dikoa in northern Nigeria, near the southwest corner of Lake Tchad, 15 days' march to the north. The road as far as Madagali skirts the mountains of Mandara, and is hilly and very stony. I had walked the 42 days' march from Campo to Rei Bouba without fatigue, but north of Garoua the elevation is much less and the heat is very enervating. A horse was accordingly hired from point to point, together with native saddle and a horse-boy.

The country is covered with low-wooded bush, but in places it becomes quite park-like. There are numerous large villages, each with a sultan, who comes out at the head of his horsemen and drummers to meet the traveler.

Thanks to the French captain in charge of the Maroua Circonscription, who had very courteously warned the chief of my coming, the party received every assistance and was provided with an escort of 10 mounted spearmen during the day's march. The sultan sent a sheep or goat for food, with chickens, eggs, honey, rice, and butter to every camping place.

The heaviest rains fall in September, but already large portions of the road were swampy and several rivers were neck deep. The crossing of a flooded river perhaps 200 feet wide was a matter of much concern to me, for once a carrier lost his footing there would be little hope of saving the load. At the first of these rivers, encountered 2 days after leaving Garoua, the first men sent over were washed off their feet and only gained the bank by swimming. It seemed impossible that carriers could cross with their loads,

and it was with much apprehension that the first and least important load (a box of food) was sent over. However, a man is heavier with a load on his head, and can keep his feet, even when neck deep in the current. Special men are needed for this work, and the escort calls them from the nearest village. They are big, strong men, at least 6 feet tall, who know the river and probably have had considerable experience in crossing it with loads. A crossing is a lengthy proceeding. The river men, after carrying over the load, return and swim across with the carriers and the horses. I was taken over either on the heads of 6 men who, in deep water, held me up at arm length, or else on a native bed under which struggled a crowd of natives. This latter is sometimes an exciting experience, the bed wobbling at all angles as man after man is washed from underneath but usually it is quite safe. Several rivers were crossed in this manner without any box getting wet.

On the fifth day from Garoua the important town of Moubi was reached, and a fresh gang of carriers and a fresh horse were hired from the sultan. Another 4 days beyond is the important native town of Madagali, where the carriers were again changed. The road now enters a plain of hard sandy clay with numerous swamps and thorn scrub. During the dry season, however, water is very scarce and there is then no vegetation except the mimosa and other thorn bushes. For the next 3 days villages are few and far between. There is no direct road in the wet season, and devious paths are followed by the local guides in order to avoid the worst swamps.

Bama on the Yadseram River at the frontier of Bornu Province in northern Nigeria was reached on the afternoon of August 31. The escort of 10 horses sent by the Sultan of Madagali returned from this point. The carriers, however, had been engaged for the journey through to Dikoa, and though they tried to desert in a body, they were held to their contract by stern measures. The road crossed the river a few miles from Bama and then generally followed the left bank of the Yadseram. The natives have no canoes, though the river is quite large, being 100 to 150 yards wide and waist-deep in places. Villages were numerous beyond Bama, fields and grassland alternating with thorn bush. The road, however, was flooded in places. A march of 2½ days from Bama placed the party at Dikoa, a town of some importance, having a daily market and a population of several thousand people. It is on the main road from Fort Lamy to Kano, and is 3 days' march from Maidugari, the nearest government post. The government rest-house is at the former German post, which was previously the palace of the famous chief Rabba, a large mud-walled compound containing many stables. The palace is built entirely of mud, with flat roofs and heavy mud pillars which resemble cloisters of a cathedral.

For the 6-day march from Dikoa to Fort Lamy, another caravan of carriers was procured from the sultan. The road, in avoiding the swamps of the Yadseram River, runs first northeast to Ngala, then east, and finally southeast through the villages of Kuda and Afade. The country is flat, and covered chiefly with low thorn scrub, but here and there are large grassy places which are swampy at this season. The villages are generally found on slightly elevated ground, and most of them are surrounded by the remains of mud walls, which now inclose fields and ruins, indications of a former prosperity.

At Kusseri, which the party reached September 9, the tall masts of the wireless telegraph station at Fort Lamy first came into view, soon followed by the red-tiled roof of the governor's residence, shimmering in the heat. It was here that Commandant Lamy gave battle to the Arab raider Rabba about 20 years ago, when the power of that oppressor was finally broken and his horsemen routed. For years he had terrorized the districts around by his slave raids, until the natives in despair appealed to the French on the Congo, for protection. At the battle of Kusseri both Commandant Lamy and Rabba were killed. Fort Lamy, which is named after the gallant commandant, is the

capital of the Tchad Territory of French Equatorial Africa, and is one of the most important towns of central Africa. There are two French trading stores, known as "factories," but the greater portion of the 80 Europeans are military officials.

Before the war, the chief route to Fort Lamy from the coast was by way of Brazzaville on the Congo to Bangui on the Ubangui River, and thence northward to Fort Crampel on the Shari River. A more direct route is from Lagos to Kano in Nigeria by rail and thence by horse and carriers eastward through Maidugari to Fort Lamy. Northern Nigeria is flat, and the road is practicable for carriage or automobile.

A caravan route from Fort Lamy to Tripoli crosses the Sahara by the Oasis Belma, but owing to the unsettled state of Tripoli and the presence of numerous bands of brigands at the oases, this route has been practically abandoned the last few years. The route eastward to Khartum on the Nile, however, is serviceable for wheeled traffic, passing by way of Abeshr, El Fasher, and El Obeid. The latter place is in rail communication with the Nile. The Ouhame-Nana Trading Company at Fort Lamy runs a small steamer twice monthly up the Shari River to Fort Archambault and in the wet season it reaches Fort Crampel. The same steamer also makes irregular trips to Lake Tchad and also up the Logone River to Bongor and Lai.

At Fort Lamy the party was most hospitably received by the governor, Colonel Ducarre, and the administrator, Captain de Ferrer, and every possible courtesy and assistance was extended by the French authorities.

The southward journey, commenced September 18, was by the way of the Logone River to Lai, thence overland to Goré, where the party turned westward to Baibokoum in the Cameroun and thence continued southward over the divide to Carnot on the Sanga River. Going down the Sanga, the party reached Ouesso, at its confluence with the Ngoko River, November 21, 1919.

The small steamer not being available, the journey to Lai by the Logone River was made in a "baleinière," a 2-ton iron boat made of galvanized iron plates bolted together. A curved cover of matting amidships provided quarters for the traveler, and was large enough to take a camp bed. The end of the rainy season was approaching, the river was in flood, and the surrounding country inundated. Hence, very poor progress was made, as the crew of 10 natives were not able to use the poles but were forced to paddle the boat close in to the flooded banks. For the comparatively short distance of 250 miles to Lai, 24 days' travel was necessary, a day often lasting from 6 a. m. to 10 p. m. The weather was hot, with stormy afternoons and nights, and the scores of tsetse and other biting flies by day, together with the swarms of bloodthirsty mosquitoes by night, made the trip very unpleasant.

In the dry season, this district is one of the finest game countries of the world, and abounds with lions, leopards, elephants, giraffes, hippopotami, rhinoceroses, buffaloes, all kinds of antelope, bush swine, ostriches, etc., but now the rank grass 10 to 12 feet high effectively hid all game during the passage of the party. All this region was formerly the favorite hunting grounds of the slave raiders from Nigeria and northern Africa. The tribes are pagan, and lacking organization and means of defense were an easy prey to the Arabs. The most interesting tribe we saw was the Mousgoum. Their high mud houses resemble huge shells standing on end, or inverted fluted funnels with the stems broken off short. To put an end to the depredations of the slave raiders, the men made the women hideous by inserting large disks of lead or copper into the lips, both upper and lower. These disks are 2 to 3 inches in diameter and produce a horrible distortion of the mouth.

Around Bongor the Banana tribe inhabits both banks of the river. They are a very simple people who have not yet reached the village stage, but live in families, with their huts surrounded by fields in which they grow a variety of sorghum. Bongor was reached

on the 14th day from Fort Lamy, October 1. Above this point the river flows through large grass flats without timber, and the villages are fairly numerous.

From Lai the journey continued by horse and carriers on October 11. Doba was reached after 3 days' march over a good road leading through wooded bush, and a further march of 3 days put the party at the abandoned French post of Goré. The post was transferred to Doba in 1912 owing to the spread of the tsetse fly and the increase of sleeping sickness. This was the last point established in French Tchad Territory, a westerly route to Baibokoum in the Cameroun being followed on October 18. A horse can not be used beyond Doba on account of the tsetse fly, and a rough bush chair carried by 4 men was therefore constructed for my use (see view 1 of Plate 3).

The country between Goré and Baibokoum has a bad reputation, but since the installation of the French post at the latter place in 1917, a good road has been made and the district gradually subdued. Rest-houses are found at intervals along the route. The streams are bridged, and most of the natives are friendly. At only one village was the chief rebellious, and here, unfortunately, it became necessary to fire 5 shots over the huts to frighten the people. The lieutenant at Doba had provided me with an escort of 3 native militiamen to ensure the security of the party, and these men proved very useful at certain places en route.

Baibokoum was reached on October 22, and the southward journey over the divide between the Lake Tchad and Congo River systems was commenced on October 24 (see view 4 of Plate 3). The nature of the country now changed from undulating wooded bush to the typical mountainous country of the central Cameroun region around Ngaoundere. On October 26 the Lim River was crossed by the canoe ferry and the Baiya country entered. These people are a large cannibal tribe extending south to Carnot, and gave trouble to the French as late as March 1919. The frequent slave raids to which they were subjected forced them to take refuge in the mountains, and for that reason their villages were of a very temporary character and a minimum of crops was sown. They were naturally hostile to all strangers, but already, under French rule, large villages are being established on the road and large plantations of manioc being made.

Leaving the Lim River, we ascended to Tinadi, climbing 1,400 feet on a rough rocky road. The elevation of Tinadi is 4,000 feet, and for the remaining 4 days' march to Bouar an altitude of 3,000 to 4,000 feet is maintained. The weather had been generally fine with few storms since leaving Goré October 19, but now on crossing the range at Tinadi the end of the wet season of southern Cameroun was encountered and heavy storms occurred in the afternoons.

Beyond Yadi the road is, generally speaking, very good, and runs directly south. Villages, however, are few and far between. From Bouar to Carnot one leaves behind the mountain plateau of the central Cameroun, gradually descending over a series of wooded ridges to the Upper Sanga River. The journey lasted 4½ days, the road being very bad during the first 2 days' travel and the villages very poor and dirty.

Overland travel ended at Carnot, from which point the Sanga River was followed to Ouesso. The first stage was to Licaya and was made in a "baleinière", provided through the courtesy of the trading company, and lasted 2 days. Bad rapids made it necessary to proceed 5 miles overland from Licaya to Bania where the recent German post now serves as a rest-house for the white traveler. From Bania the journey was continued to Nola in another baleinière, one day being sufficient for this portion of the river trip. Nola, at the confluence of the Kadei and the Sanga, is an important post which is served twice a month from October to December by a small trading steamer from Ouesso. Formerly it was very prosperous, even though many Europeans were stricken with the dreaded sleeping-sickness. I decided not to await the steamer but resumed the journey down stream November 16 in a large canoe kindly placed at my

disposal by M. Beau, agent of the trading company. The distance by river from Nola to Ouesso, where we arrived November 1, is about 200 miles. On this stretch of the river the tsetse are numerous enough to be unpleasant. Both Carnot and Bania have many cases of sleeping sickness, but strange to say they have very few flies, while from Nola to Ouesso and thence to the Congo, the tsetse flies are found in great numbers, while cases of sleeping sickness are comparatively few. The river from Carnot southward is heavily wooded along its banks and at Bania enters the great equatorial forest. It flows through hilly country as far as Bayanga, after which the forest is generally flat. Villages are quite numerous, and are usually found on high banks overlooking the river. At Ouesso, the end of the southern journey, every possible courtesy was extended by M. Bruère, the Administrator. Two trading stores enable the traveler to provision himself well for the bush. The trip from Ouesso to Bonga at the confluence of the Congo and Sanga, about 250 miles to the south, was abandoned as the monthly steamer to Brazzaville had left 2 days prior to my arrival, and a return journey by canoe would have consumed too much time.

The westward journey across the south Cameroun was commenced on November 26, a small trading steamer taking the party to Ngoila on the Ngoko River about 100 miles west of Ouesso. There the overland journey to Abong-Mbang was commenced, the route leading by way of Sembé, Souanke, and Lonié. This is the most direct route. The other main route from Moloundou (70 miles west of Ouesso) first runs north for 9 days to Youkaduma and thence turns westward to Doumie and Abong-Mbang.

Leaving Ngoila on November 30, Sembé was reached the next day, after a march through a thick forest. An escort was supplied in this district as a protection against the remarkably large and ferocious gorillas which kill a number of natives on the main forest paths every month. There is a government post and a trading factory at both Ngoila and at Sembé. A further march of 2½ days on a good road leading through the same thick forest, with frequent villages, was sufficient to reach the post of Souanke. Leaving Souanke the road turns north to the old German post of Eta, on the original Cameroun-Middle Congo frontier, a native track leading over thickly forested hills and unbridged torrents. The hills are very steep, and the overhanging vegetation is too low to permit the use of a chair. From Eta onward the road is much better, though the favorite form of bridge in this region is a tree or a few sticks, usually half rotted through. At almost every village the chiefs and headmen speak pidgin-English, so that an interpreter is not necessary. In all the coastal area the natives speak English, and at every village as far north as Tibati I was able to use English also all the way to Garoua, but beyond an interpreter was necessary. In the new Cameroun, French is spoken by many natives, hence an escort of native tirailleurs taken from post to post is very useful in dealing with the natives.

From Souanke to Lomié is a journey of 5½ days; villages are not numerous on this route, and there are frequent stages of 6 or 7 hours of forest without anything to break the monotony. The Dja River is crossed at Nkul by ferry on the fourth day. One marches in deep shadow even at noon, and thus travel is not fatiguing and long stages are feasible. The dry season had now set in, cloudy days giving way to cool, starry nights, with thick mists lasting until 8 or 9 a. m.

At Lomié the government post, Fort Niger, is pleasantly situated on a hilltop overlooking rolling forest country. There are several trading factories, but as they cater to the natives, the European has small chance of obtaining supplies.

A march of 4 days, further north, over pleasant forest country with numerous villages, brings one to Abong-Mbang. The road is in very good repair and crosses the many clear streams by small wooden bridges. Nearing Abong-Mbang it leaves the hills and runs down on to a swampy plain. The old German post, at present deserted, is a

square red brick fort on the south bank of the Nyong River. There are three trading factories, where rubber, chiefly, is bought from the natives in exchange for money, cloth, or salt. Abong-Mbang is the head of navigation of the Nyong, which springs from the swamps to the east and south. The actual channel was but 10 meters wide here and winds through swamps of high grass like those found throughout the 200 miles of voyage downstream. The water is clear, but of a blackish color, and has a gentle current. The descent from Abong-Mbang to Onana-bessa can be made in about 6 days, while the ascent takes 10 or 12. A fine large canoe was very kindly provided by M. Blat, and a comfortable and interesting trip of 5½ days' travel was made commencing December 17. The tsetse fly is numerous in places, and plague the traveler every minute of the day. Opinion is divided as to whether there is any sleeping sickness along the river. At Ayos, on a hilltop some 50 miles west of Abong-Mbang, are the remains of the German sanatorium which was erected for cases of sleeping sickness. After 2½ days' paddle, the post of Akonolinga was reached, where there are several trading factories, and where for the first time since the party left Yaounde July 2, telegraphic communication with the coast was possible. Beyond Akonolinga the river becomes very sinuous, twisting its way through steep timbered hills. The rivers of the Cameroun are not very scenic, but the Nyong in this part of its course is quite pretty. It is 100 to 150 meters wide in this stretch. The marks of flood water on the banks showed that the stream had fallen about 3 feet since the end of the wet season in November. A few rapids were passed just above Onana-bessa, which is the lower limit of navigation on this stretch, the river from that point entering the hilly coastal area and falling some 2,000 feet in the remaining 130 miles of its course to the sea.

The American mission station at Olama was reached after a 4-mile walk from Onana-bessa on the evening of December 23, and a very happy Christmas was spent with Reverend and Mrs. A. B. Patterson, whose kindness and cordial hospitality were very much appreciated. At the invitation of Reverend Mr. Patterson, it was decided to make a stay here while awaiting a steamer sailing south from Douala, and thus the preparation of the report and the reduction of the observations were made under very favorable circumstances, at a cool mission station 2,000 feet above sea-level, in many ways preferable to the humid, enervating coastal town.

On January 12, I left Olama for Douala by way of Makak and Eseka, intending to catch the French mail-boat *L'Afrique* which was due at Douala about January 22. From Makak to Eseka the road is very hilly, but this section soon will have a light railway service. The French are pushing forward the continuation of the railway to the Nyong River, whence a motor service will link up Yaounde with the rail-head. Eseka (see view 5 of Plate 3), the present terminus of the Cameroun Central Railway, 110 miles from Douala, is about 60 miles from Olama and was reached by noon of January 14. The first day a small bush track was followed over hilly country with frequent villages and farms, and by evening the main motor road from Makak to Ilik-ngumu (on the Kribi-Yaounde motor road) was reached.

At Eseka the party bade farewell to the Cameroun bush and travel by carriers, completing the journey to Douala by rail after observations had been made. I arrived at Douala January 17, and learned that the steamer *L'Afrique* was a total wreck near Bordeaux, with a loss of over 400 lives. M. Carde, the Governor, very courteously allowed me to proceed south in the French cruiser *Regulus*, which sailed January 24. Meanwhile, the report and reduction of cahiers were completed, and the necessary arrangements made for leaving.

Throughout the field work I had been accompanied by a cook-boy, a Bulu named "Mba," who rendered fair service. The work and travel proved most interesting, especially in the north Cameroun. I enjoyed good health, except occasional feverish

chills caused by the sudden storms of the wet season, when the temperature falls rapidly. A dose of 5 grains of quinine should be taken daily. With this precaution the traveler need never fear the climate, provided he also takes a reasonable amount of exercise.

Table 17 gives names of the magnetic stations, dates of occupation, and geographic positions; for magnetic elements, see Table of Results.

TABLE 17.

No.	Name [1]	Date	Lat. North		Long. East	
		1919-20	°	′	°	′
1	*Douala*	May 3	4	02.4	9	43
2	Douala, *B*	" 5	4	02.4	9	43
3	Nkongsamba	" 9	4	57.3	9	57
4	Lum	" 10	4	42.6	9	45
5	Kompina	" 13–14	4	21.6	9	36
6	Edea	" 16	3	47.7	10	08
7	Campo, *Eclipse*	" 24–June 2	2	20.8	9	50
8	Rio Campo	" 3	2	20.5	9	50
9	Kribi	" 9	2	56.4	9	55
10	Efulen	" 13–15	2	47.4	10	32
11	Ebolowa	" 19	2	54.4	11	09
12	Olama	" 23	3	25.5	11	16
13	Yaounde	" 28–July 1	3	51.3	11	32
14	Sanaga	" 4	4	21.0	11	39
15	Nghila	" 6	4	43	11	42
16	Mangal	" 9	5	12.4	12	12
17	Yoko	" 11–13	5	32.1	12	20
18	Boudjiri	" 16	6	03.7	12	28
19	Tibati	" 18–19	6	28.0	12	33
20	Kaega-Matekel	" 21	6	48.0	13	07
21	Mancha	" 23	7	07.5	13	13
22	Ngaoundere	" 25–26	7	18.6	13	29
23	Heldu	" 31–Aug. 1	7	42.1	14	06
24	Ndium Ndunajum	" 4	8	12.1	14	12
25	Rei Bouba	" 7	8	40.0	14	10
26	Lagdo	" 9	9	02.8	13	41
27	*Garoua*	" 12	9	17.4	13	24
28	Garoua, *B*	" 14–15	9	18.3	13	24
29	Ssorao	" 21–22	9	44.7	13	15
30	Moubi	" 24	10	16.4	13	14
31	Douhou	" 27	10	46.9	13	26
32	Bama	" 31	11	31.0	13	41
33	Yale	Sep. 1	11	42.4	13	42
34	Dikoa	" 3–4	12	01.7	13	54
35	Ngala	" 6	12	20.6	14	10
36	Afade	" 8	12	14	14	37
37	*Fort Lamy, B*	" 12–13	12	06.6	15	02
38	Fort Lamy, *A* [2]	" 13–15	12	06.6	15	02
39	Fort Lamy, *C*	" 16	12	06.7	15	02
40	Logone Gana	" 23	11	33.9	15	09
41	Mousgoum	" 27	10	55.0	15	07
42	Bongor	Oct. 1–2	10	17.4	15	25
43	Djimmane	" 6	9	53.1	15	50
44	Lai	" 9–10	9	23.7	16	18
45	Doba	" 14	8	39.0	16	53
46	Goré	" 17	7	55.7	16	38
47	Beguekai	" 19	8	02.1	16	13
48	Baibokoum	" 22–23	7	44.6	15	44
49	Lim	" 25–26	7	17.0	15	32
50	Gama	" 29	6	30.4	15	38
51	Bouar	" 31–Nov. 1	5	56.6	15	35
52	Boudei	" 3	5	38.3	15	49
53	Carnot	" 6–7	4	56.4	15	53

[1] The stations are in the following countries: Nos. 1 to 7, 9 to 32, 34 to 36, and 65 to 73, Cameroun; No. 8, Spanish Guinea; No. 33, Nigeria; Nos. 37 to 64, French Equatorial Africa.

[2] Point previously occupied by Tilho.

TABLE 17—*Concluded.*

No.	Name	Date	Lat. North	Long. East
		1919–20	° ′	° ′
54	Baboko	Nov. 9	4 34.4	16 08
55	Bania	" 10–11	3 59.8	16 08
56	Nola, *A*	" 13–15	3 31.4	16 04
57	Nola, *B*	" 15–16	3 31.4	16 04
58	Bayanga	" 17	2 54.4	16 16
59	Bomassa	" 19	2 12.4	16 13
60	Ouesso	" 22	1 36.9	16 04
61	Moloundou	" 27–28	2 02.3	15 14
62	Ngoila	" 29	2 01.3	14 55
63	Sembé	Dec. 2–3	1 38.8	14 36
64	Souanke	" 5	2 04.1	14 09
65	Teisan	" 8	2 41.0	14 03
66	Lomié	" 11–12	3 09.5	13 41
67	Doumo	" 14	3 37.7	13 26
68	Abong-Mbang	" 16	3 59.7	13 12
69	Atok	" 17–18	4 01.6	12 47
70	Akonolinga	" 20	3 46.2	12 15
71	*Olama*	" 31– Jan. 1	3 25.5	11 16
72	Eseka	" 15–16	3 39.1	10 47
73	*Douala, B*	" 20	4 02.4	9 43

The total time occupied in work was from May 3, 1919, to January 24, 1920, a total of 267 days. With the 73 stations occupied, the average time for a station was 3.6 days. The total distance traveled in the field, exclusive of the sea trip from Liverpool to Douala, was 3,561 miles. The average distance between stations is 49 miles. In addition to the stations listed in the foregoing table, there were two stations occupied en route from Liverpool to Douala. The total traveling expenses exclusive of the steamer fare were $930, making the average cost per station about $13. Generally speaking, the formation throughout the Cameroun is laterite. In the central portion the mountains of the Ngaoundere district are of granite gneiss, while further to the west, the mountainous country extending from Mount Cameroun on the coast, northeastward along the Nigerian frontier, is basaltic. Granite and quartz outcrops often occur in the laterite formation. The soil generally is a reddish clay. The exception to the foregoing remarks occurs in the extreme north where the Cameroun territory tapers to a point at Lake Tchad, and where the Mandara Mountains, with their fantastic reddish pinnacles and crags, push northward as far as latitude 11° 20′, and then abruptly end. Their northern extremity is surrounded by a great plain, inundated in the wet season and partly desert for the remainder of the year, on which the soil is a hard sandy clay with no rocks or pebbles. This same formation is found on the Logone River from Fort Lamy to Lai, but at the latter place the laterite reappears. Cameroun Mountain on the coast is a mass of basalt 4,000 meters high and seems to be a semi-active volcano. The southern and central parts of the Cameroun are subject to occasional earth shocks which last from one to several seconds. At the government post of Bouar, a distinct shock was recorded in March 1919, while Cameroun Mountain was active in 1917. Gold in small quantities is found in the mountainous region of the central part, where mineral springs also occur.

Although the soil is ferruginous, very few places showed a pronounced local disturbance. In some regions the natives smelt laterite rock to obtain iron for their spear heads and knives, but the ore is obtained from special spots which were always too far from the road for me to visit. The observations at Lum on the railway from Douala to Nkongsamba indicate a large local disturbance, and tend to strengthen a belief in the existence of a high-grade iron ore in that district. The upper Sanga Valley from Carnot to Nola appears to be magnetically disturbed.

Throughout the expedition the party received every courtesy and assistance from the French authorities. The Governor, the Honorable Carde, gave material assistance in providing a letter of introduction addressed to all officials of the colony, and also in permitting the issue of certain bulky items of food from the government stores in the interior. I was most hospitably entertained at the government posts, where carriers for the next stage of the journey were always supplied, and materials and labor provided for marking our magnetic stations. Acknowledgments are also made to the various trading companies, both French and British, their agents being most friendly, entertaining the party and occasionally helping to secure canoes for the journey. In the south Cameroun the American Presbyterian Mission stations were very helpful and most hospitable. Advantage is taken of the opportunity in this report to express our thanks to Colonel Ducarré, Commandant of the Territory of Tchad for the courtesies and assistance extended to the party at Fort Lamy; to Captain de Ferrer; to Captain Audoin, Commandant of the northern region of Cameroun, who was especially interested in the work, having made magnetic observations with the Tilho expedition; to Lieutenant Petit, Chief of Sub-division of Campo; to the Reverends Hoesington, Heminger, and Patterson, also Mr. Hope of the American Presbyterian Mission; to Mr. Shuttleworth, the Director of John Holt and Company, and his agents, Messrs. Buckle and Haeckler; to Mr. D. Croxford, the Director of R. and W. King, Ltd.; to Mr. Hilaire, Ouesso; to Mr. Beau of Nola; to Mr. F. Blat of Abong-Mbang; and to M. René Bruère, Administrator at Ouesso.

FACILITIES AND SUGGESTIONS FOR TRAVEL OR WORK.

A very good map of the Cameroun is published by the British War Office [1] on a scale of 1:2,000,000. The sectional maps by Moisel under the name of "Karte von Kamerun" are most useful and very accurate.[2] They appear as a series of about 40 sectional maps on a scale of 1:300,000. A good general map of West Africa is the "Carte Barralier de L'Afrique Equatoriale Française."[3]

Small rest-houses and camps are found on all the main roads, so that a tent is not a necessity except in the great forest zone in the southeast portion of the Cameroun. A camp chair, table, and lamp should be taken and a portable canvas wash-bowl, bath, and an easy chair (deck chair) can be carried with advantage. As good water is found throughout the Cameroun, a large filter is not necessary, but a small pocket filter might be added for emergency use. A folding bed of the X-frame type and a mosquito-net are essential. A wooden frame for supporting the net is very convenient. Waterproof sheets are of very little use in the tropics; a good closely-woven canvas cover is much more practical. Candle-light is very trying for the eyes in computation work at night, and if a good oil lamp can not be obtained, a Dietz storm lantern should be taken. Kerosene can be carried in wine bottles, and a dozen of these, each holding 1½ pints, lasted 3½ months.

In normal times supplies such as flour, sugar, tea, tinned meats, biscuits, etc., can be obtained at the factories at Douala, Kribi, Yaounde, Garoua, Fort Lamy, Nola, Ouesso, and Eseka. Prices, however, are high, and it would pay to purchase supplies in London or in the United States before sailing. Tinned milk should be carried for use in case of sickness, while Oxo soup cubes and Horlick's malted milk tablets in hermetically sealed tins are very useful for emergency meals. Chickens and eggs can be obtained throughout the Cameroun, and fish also near any of the large rivers or mountain streams. A fine variety of fruit is found in the south, but none in the central and north parts of

[1] British War Office, Geographical Section, General Staff No. 2793, July 1915.

[2] Published by Dietrich Reimer (Ernst Vohsen), Berlin, S. W. 48, Wilhelmstrasse 29. The same publisher also supplies several geological books on the Cameroun.

[3] Published by "Libraire Challamel," 17 Rue Jacob, Paris.

the Cameroun. European vegetables also do well in the south. The posts and trading factories have gardens of potatoes, onions, cabbage, carrots, turnips, haricot beans, and peas. One can not obtain potatoes beyond Ngaoundere, though onions, tomatoes, and haricot beans are found at every post as far north as Fort Lamy. At towns like Tibati, Ngaoundere, Rei Bouba, and Garoua, where daily markets are held, butter, milk, and beef can be procured; the country north of Garoua also supplies these foods, besides rice and honey.

A rifle, a shot gun (12 bore, 8 large shot to the cartridge), and a revolver are necessary, not so much on account of the natives as the wild beasts. Buffaloes and gorillas sometimes attack without provocation, and leopards in certain districts enter the villages and carry natives off into the bush. A first aid case is necessary and also a good supply of quinine. Electric pocket lamps are of little use, owing to the rapid deterioration of dry batteries. Though the northern Cameroun is fairly dry, the forest regions in the south are very humid, and for this reason tin water-tight boxes and trunks are desirable for books, papers, and clothes. As a load must not exceed 60 pounds in weight, a serviceable tin trunk should be about 31 inches long, 15 inches wide, and 9 inches deep. Except in the coastal areas, cool clean water can be procured at most places, and thus the development in the field of photographs is not difficult. Good results were obtained with a Kodak camera and a daylight developing tank. The developing powders in glass tubes, sold by the Kodak Company, are preferable to those supplied in cartons or tins. Money can be obtained in the interior at several points on money orders purchased at Douala. For work in the north and central Cameroun, a boiling-point apparatus for altitude work might be useful.

In addition to the main routes followed by the observer, there are many others which would present no difficulty, within the Cameroun Territory. A main road leads from Nkongsamba, the terminus of the Northern Railway, 100 miles from Douala, to Garoua or Yola via Fumban, Banio, and Kontcha. This route runs through a basaltic formation near Fumban, and is very mountainous. In the central Cameroun a road can be followed from Yaounde to Deng-Deng, thence to Kunde, and thence to Ngaoundere or to Bouar and Bangui. Another route from Yaounde leads through Akonolinga to Doumie and thence eastward to Youkaduna and Nola on the Sanga River.

The caravan routes across the Sahara from Lake Tchad to Tripoli or Alexandria are still closed by hostile natives who take refuge in the mountains of Tibesti, and the French have withdrawn from their outposts in that region. From Kano, the terminus of the railway from Lagos in Nigeria, a route leads northward to Zinder and thence across the Sahara Desert by way of Agades, Haggar, and In-salah to Algiers. An alternative route from Kano to Zinder and Nguigmi passes along the north Nigeria from Kano to Maidugari and Dikoa to Nguigmi. In the dry season, from about November to July, there is motor service between Kano and Maidugari and a motor service between Kano and Zinder will probably be organized in the future. A road leads from Zinder eastward to the posts of Gaedam and Nguigmi. Nguigmi has a wireless station and is situated near the northwest corner of Lake Tchad. From Nguigmi the oasis Bilma can be reached without any difficulty by way of Bedouram and Agadem. At Bilma, where the French government post is equipped with a wireless station, the traveler would have a choice of three routes: (a) The old caravan road to Murzuk and Tripoli. (b) The route leading through Djanet, Rhat (Ghatt), Ghadames, to Tunis or Ouargla; north of Bilma there are fewer wells and more danger from brigands; between Bilma and Ghatt there is said to be but one well, that of Djanet. (c) An emergency route from Bilma west-southwest to the oasis of Agades and thence northward to Algiers.

The best time for the Sahara journeys is the wet season, when the pasturage is good, between May and November. The route from Zinder to Agades[1] is dotted with permanent villages through half the distance, and pasturage and wells are found throughout.

[1] See Mission Foureau, Documents Scientifiques de la Mission Saharienne, Paris.

F. BROWN, ON TRANS-AFRICAN MAGNETIC EXPEDITION, ANGOLA TO MOZAMBIQUE, JANUARY TO OCTOBER 1920.

After the completion of the work in Cameroun in January 1920, I prepared to proceed southward to take up the work in Angola, occupying repeat stations en route in accordance with instructions of March 7, 1919, and using the instrumental outfit which had been carried on the previous expedition. It had been my intention to take passage on the mail steamer *L'Afrique*, but this was impossible owing to the distressing loss of that vessel off Bordeaux with all on board. I was saved from a delay of 6 or 7 weeks at Douala by the courtesy of the Commander of the French cruiser *Regulus*, who, with the permission of the Governor, invited me to accompany him. I most gladly accepted this invitation and proceeded southward as a guest of the officers of the vessel. We arrived at Boma on February 4, opportunity having been afforded for observations at Libreville, Port Gentil, and Banana, all repeat stations. At the last-named point the Commander very kindly set me ashore after a most pleasant two weeks as a guest. From here passage was taken on the Belgian steamer *Wall*, which arrived at Loanda on February 14. Besides making the necessary official preparations for work in the interior of Angola, I was able to carry out a short series of comparisons with the instruments of the Loanda Observatory which was expected to begin operations very soon, with a complete equipment of magnetograph instruments. From Loanda I was also able to make a short trip by rail on the weekly passenger train eastward to the present terminus at Malange, where the station of 1915 was reoccupied.

I arrived at Lobito Bay by steamer from Loanda on March 14 and left on March 31 by rail for Huambo and Xinguari. Leaving the rail-head (500 kilometers from the coast) on April 7, with carriers, I followed the old slave route which runs east along the 12th parallel to Kavungo, where I arrived May 26. The route then extends northeast, touching Kalene Hill in the extreme northwest corner of Rhodesia, and enters the Katanga District in the Belgian Congo near Dipudi. Chilongo, on the Belgian Katanga Railway, was reached on June 19, from which point I continued by rail to the Victoria Falls on the Zambezi.

The second half of the trans-African trip began at Kafue, a small town about 100 miles south of Broken Hill. Setting out with carriers July 23, I followed first the Kafue and then the Zambezi rivers to Feira, in the southeast corner of Northern Rhodesia. Thence the journey to Chinde, at the mouth of the Zambezi, was made by canoe as far as Chindio with one overland stretch of 100 miles to avoid the unnavigable part of the river. At Chindio a river steamer was taken for Chinde, where I arrived September 21. The crossing of Africa thus lasted almost 6 months. Beira was reached on September 25 by a coasting steamer from Chinde.

At the outset a stay of 2 weeks was necessary in Lobito to complete the arrangements for the journey into the interior. Only one day was spent in the purchase of stores, but the chief cause of delay was the lengthy procedure necessary to obtain a license for carrying a rifle. This usually takes one month, so that unless one is making a lengthy trip in Portuguese territory, it is advisable to dispense with firearms. There are well-equipped stores both in Lobito and Benguela, but camp furniture and equipment are not obtainable in either place. A well-built railway runs into the interior 500 kilometers from Lobito, and construction is being carried on to Belmonte. It is intended to continue the railway eastward to Kambove in the Belgian Congo. Leaving Lobito the train soon passes the old slave town of Catumbella, and on the hills beyond the old slave trail from the interior is plainly seen, marking the end of a cruel journey of many months for the unfortunate slaves who were captured in Central Africa when the "black ivory trade" was in full swing not so very many years ago. We also got a view of the giant baobab mentioned by Livingstone in his book.

Benguela, 23 miles from Lobito, is a well-planned town on the seacoast, with large cool houses of stone and plaster, many of which are surrounded by high-walled compounds, a relic of the old slave-days. Soon after leaving Benguela, the railway climbs over an arid mountainous region, after which it runs over a pleasant wooded plateau, where the fresh cool air is a delightful sensation to the traveler from the west coast. There are no large settlements, though the region round Huambo and Bailundu is suitable for agriculture and grazing. After the completion of observations at Huambo (5,400 feet above sea-level), where one station (1916) was reoccupied and another established, the journey was continued by rail to Bela Vista, where I was hospitably received by the American Board Mission Station. Owing to the difficulty of engaging carriers at the rail-head, Xinguari, a caravan was formed at Bela Vista and the overland journey commenced April 7. Observations were made at the rail-head the same day, and the party continued to Belmonte, the administrative capital of the Bie plateau, a journey of about 75 kilometers. An automobile meets the weekly mail train, but as there is no arrangement for baggage, we did not use it. In general, the motor-road was followed over a wind-swept, rolling plateau, with grassy, well-watered valleys and wooded ridges. A few native villages were passed en route, besides a few plantations worked by white men. There are no rest-houses and it is therefore necessary to camp. The natives carry loads of 30 kilos, besides the 5 kilos they add for their few personal effects and rations for the journey. It is customary to give each man 1 kilo of meal flour, a few beans, and a spoonful of salt for a day's ration.

Belmonte was reached on the morning of April 10. It is a small town with a hotel and a few stores built around the early settlement made by the Portuguese pioneer Selva Porte. A motor road has been constructed to the Cuanza River, about 70 miles distant, but again it was necessary to trek with carriers because the equipment and supplies for the long overland journey were too bulky. A caravan of 30 carriers was assembled at the American Board Mission station of Camundongo with the kind help of the missionary, Mr. W. H. Sanders, and a start was made for Moxico, April 15. Beyond the Cuanza lies the "Hungry Country," so named because for a march of 250 kilometers no supplies are obtainable. There is but one Portuguese post, midway, and but one village. This stage of the journey therefore presents some difficulty to the traveler, as food for about 15 days must be carried. The custom is to give to every two carriers a youth to carry their food; hence for the 20 men employed to transport the equipment and supplies, 10 boys were taken. The Biheans, or Umbundu tribe of the Bie district, are fine carriers, and by early contact with the Portuguese, are somewhat civilized. In the slave raiding days they were sent in parties far into the interior, with supplies of guns and powder, knives and cloth to barter for slaves with the various chiefs. Their wanderings often took them as far as Lake Tanganyika and even across to the Lower Zambezi. The slaves so procured were then marched down to the west coast, carrying loads of ivory and rubber.

The climate on the Bihe Plateau was delightful; fine, sunny, cloudless days, comfortably warm in the sun, and cold nights. In June and July (winter months), frost and ice form in the valleys. It is good cattle country, while European fruits and vegetables, besides oranges, lemons and limes, are grown with great success.

After leaving Camundongo, we regained the motor-road at Belmonte (18 kilometers) and followed it to the Cuanza Fort, after a stay for observation midway at Chissamba. The road gradually descends from an altitude of 5,500 feet at Belmonte to 4,300 feet at the Cuanza River, which is crossed by a pontoon, large enough to take wagons. The fort was reached April 20 and observations were made the same day. On April 22 the "Hungry Country" was entered in real earnest, and several human skeletons were passed during the morning's march, the remains of unfortunate carriers who had fallen

sick or gone lame and had been left to die by their companions. The trail crossed a succession of ridges covered with low timber and scrub, and separated by narrow grassy valleys through which flow small rivers and streams of cold clear water. The trail on the ridges is often very sandy, while the river valleys are swampy along the stream beds. On April 26 the post of Munhango was reached and observations were made the same day. It is built on the steep side of a wooded ridge which forms the watershed of three river systems. A tributary of the Zambezi River rises on the south, on the north is the source of the Kasai, an important tributary of the Congo, while a third stream rises on the northwest slope to flow into the Cuanza, the largest river in Angola.

Munhango to Moxico takes a march of 5 long days over picturesque wooded country intersected by grassy valleys. There are good rest-houses for lodging, but no food is obtainable, and in the dry season water is scarce. Moxico was reached on May 2, after a march down the Simoi River, which near the settlement runs between picturesque, steep hills. The Governor of the district resides here, and some good roads are being made for wheeled traffic. The route followed by carriers is too sandy for motor traffic, but the old Boer wagon route, which follows along the Zambezi-Congo divide, is said to be of more solid formation. The Spanish influenza had Moxico in its grip on arrival there, so that it was necessary to isolate the carriers and complete the observations as speedily as possible. A departure was made the next day for the English mission station of Boma, about 12 kilometers to the eastward, where the Camundongo men were paid off and rationed for their return journey across the "Hungry Country." As the local natives were all suffering from influenza, a delay of a week was experienced before men could be engaged for the journey to Nana Candundo (Kavungo), 400 kilometers more to the east.

The Chokwe tribe of the Moxico district are a proud, insolent people, whom the Portguese have had considerable difficulty in subduing. In the old days they were really highway robbers and would hold up carriers, 1,000 strong, to extort "presents." They gave trouble to every traveler through their district, including Livingstone and Arnot. For a long time they refused to carry loads, "to become white men's slaves," as they termed it, and the hut-tax has only been enforced during the last five years. The men are of medium height and of sturdy build, making good carriers. Their dress is scanty, a piece of cloth tucked into a belt around the loins or two pieces of goat skin hanging down almost to the knees. The women are not inferior to the men in size, but their dress is even more scanty. A tiny scrap of cloth is worn in front with brass armlets, bracelets, and necklaces. The head is dressed in a most peculiar fashion. With the aid of a stick the hair is twisted into a series of clots or lumps, which are soaked with castor oil and plastered with red clay.

A start was made on May 10 for Kavungo, to which there is a cleared road most of the way, with rest-houses scattered rather far apart for a day's march. The country is still very lonely, and but few villages were seen during the 17 days' march. The altitude varies from 3,500 to 4,000 feet, but as one proceeds eastwardly the ridges are found to be less pronounced, while the grassy belts and plains become wider and more swampy. During March and April this section of the route is impassable, the rivers and swamps often being many miles wide by the end of the rainy season. After a march of 2 days from Boma a detour to the north was made to reach a farm named Cazeze, which is on the surveyed railway route. The main road was regained at Chabaia, about 50 kilometers to the east. The winding native track touches the Kasai River, where a few villages are located in which eggs and fowls can be bought for money or salt. The Portuguese post of Dilolo was reached May 20, after the road had been followed across wide grassy and slightly swampy plains, which alternated with belts of thick scrub or park-like country where the grass was waist to shoulder high. Dilolo is prettily situated on the

western shore of a fine lake. The fort is of the usual type, a square raised earthwork with a dry moat around and circular "tambours" at the corners. Inside were the residence of the commandant, a store, and a prison. The large mound built by Captain Lemaire to mark his observation spot of 1899 could not be found, and no information concerning it could be obtained from the local natives. On leaving Dilolo we found a rest-house the first day at Lutembo, built on a ridge overlooking a bad swamp, about 1 mile of which had to be traversed in a canoe. Transport of 21 carriers with their loads under such conditions is a lengthy proceeding which consumed 5½ hours. The following day we found the main road turned off southeast to Kazombo, which is the administrative center of the frontier region.

Several sinuous, sluggish, mangrove-lined rivers were crossed during the next 3 days' march, some by canoe and others by tottering native bridges of dead sticks. One afternoon the noise of tom-toms and much shouting at a village ahead announced the performance of some rite or ceremony, which proved to be a trial of some unfortunate witches by a witch-doctor, "smelling-out" evildoers. An open space in the bush was lined by excited men and women, and at one end, in a hut of green boughs, were huddled the prisoners. The witch-doctor was a large, evil-looking man, carrying all the accessories of his craft in his hands, and wearing a head-dress of feathers. His face was painted red, and he paraded up and down between two lines of villagers, making contortions and gesticulations to the accompaniment of a low chanting. He was preceded by a band of half a dozen youths whose bodies were painted with yellow, red, and white stripes. At the end of the clearing opposite to the hut, one man was beating himself and wailing and making a great show of grief. Such practices are forbidden by the Government, but in remote districts they are still continued.

Kavungo was reached on May 26, where a cordial welcome was extended to me by the English missionaries. The Chokwe carriers were paid off and sent back, without regret on either side. It had been necessary to teach them travel-discipline on several occasions, once after several, including the carrier of the "chop box," had stayed out in the bush all night. The final overland stage of about 420 kilometers to the Katanga Railway at Chilongo in the Belgian Congo was commenced June 2, and covered by June 19.

On leaving Kavungo the traveler again finds the country more undulating with numerous rivers, difficult to cross because of the swamps which line them. The main road has rest-houses and is cleared throughout. It passes by way of Kai Anda on the Belgian Congo frontier, and then turns south to Kalene Hill in the extreme northwest corner of Northern Rhodesia. At the Mwandeje rest-house, 2 days' trek from Kavungo, a Kaffir path was taken direct to the abandoned fort of Bumba, which was reached June 6. The villages in this district are surrounded by palisades and thorn hedges on account of lions, and the carriers preferred to sleep in the middle of a village in such localities. We arrived at the frontier on June 7, at the Jimbi River, where British territory was entered and a camp made that evening on the bank of the Zambezi River, a picturesque stream, at this place about 50 feet wide, flowing in a rocky bed with many rapids.

The English Mission station of Kalene Hill was reached next morning. It is perched on the north end of a quartzite escarpment rising 450 feet above the country on the west, and commands a fine view of the Zambezi Valley. A very pleasant stay was made here for observations, and on June 10 the Zambezi was again crossed at a point 15 miles from its source, and the Belgian Congo entered the same afternoon. The country soon becomes very hilly, maintaining altitudes from 3,500 to 4,500 feet above sea-level. There is the usual alternation of wooded bush and grassy plain, with numerous rivers and swamps. A day was spent in the Musokantanda Plain in company with Dr. Fisher, the

pioneer missionary of that region, on a hunting trip after roan-buck and hartebeest to provide food for the men, but though fresh spoor was followed, the game was never sighted. Strange to say, there is very little game in Angola, along the route followed. None was seen, though on one occasion two lions chased the cook-boy up a tree when he had lost the trail. The best hunting is on the plains, after the grass has been burnt off by the natives and the fresh young green shoots appear. On June 16 we saw the first of the copper kopjes. Katanga is very rich in copper, gold, and tin, and numerous copper hills, easily distinguished by their barren appearance, were passed as we approached the railway. The 1914 Ruwe station was reoccupied on June 17, and the Lualaba River was crossed by canoe next day. It is about 100 yards wide and was the largest river seen on the journey. A very winding native trail had been followed, until it joined a good road built for motor-lorries within a few miles of Ruwe. The exploitation of this region is now being seriously undertaken, and copper mines of surpassing richness are being worked.

Chilongo is on a plateau about 5,000 feet high, and consists of a few stores grouped around the railway station. The journey to Kambove was made in a goods-train the day after arrival, and a stay of one week was made for repeat observations and reduction of the work. Kambove owes its importance to its copper mine; the town itself is not very extensive, but contains a hotel and several well-equipped stores.

The rail journey was continued to the Victoria Falls, stops being made at Elisabethville and Broken Hill for repeat observations and dispatch of records to the Office. Elisabethville, with a white population of 1,000, is one of the largest towns of Central Africa and is the capital of Katanga. There are several hotels, banks, stores, and a cinema. It owes its prosperity to the Lubumbashi copper smelters near-by, at which all the copper from the Katanga mines is smelted.

For the remaining half of the trans-African trip, I decided to start from Kafue instead of Broken Hill, after learning that canoes were procurable at the Kafue-Zambezi junction. At Livingstone, however, I was advised that the rapids were dangerous at that season and so I arranged for carriers to be sent from Broken Hill for a trip to Feira by land. On July 23 the start was made for Feira, a British post in the southeast corner of Northern Rhodesia, on the frontier of Portuguese East Africa, 180 miles distant. The road follows down the Kafue River to its junction with the Zambezi. Kafue is a pleasant little township with a hotel and several well-equipped stores, situated in the middle of a farming region. The river is navigable for launches about 150 miles above the railway bridge, but just below, it enters the mountains and runs through a succession of gorges and rapids. A short distance from the town the cart road ends, and one continues by a rough native path into the Kafue gorge. The mountain scenery is very fine and the most picturesque of my trip across Africa. The first three camps were in the mountains, but on the morning of July 26 a steep descent was made into the valley of the Kafue River near Mbosa, where the mountains are left and the path crosses only occasional foot-hills. The difference in level of the river above and below the gorge is about 2,000 feet.

From Mbosa onward to Mburuma the path is cleared, and one finds small rest-camps at frequent intervals, containing an open hut for use as a dining room for the white man, and a few other huts for the carriers. A tent, however, is necessary. In the Zambezi valley the flats are covered with low bush and a fine variety of thorn bushes. Villages are numerous and supplies can be obtained. A cupful of salt was given for a chicken and a teaspoonful for an egg, while each carrier received one-fourth pound of salt per day, which he bartered for corn meal at the villages. English silver money can be used, but unbleached calico is most appreciated as a medium of exchange. The spoor showed that game is plentiful in this region and included buffalo, water buck, zebra, lion, hippopotamus, and various kinds of antelope.

Mburuma is a large native village of several hundred huts, but most of the native kraals are small and do not compare with the clean, well-built villages of West Africa. The native method of greeting the white man is rather curious. When about one-fourth of a mile from a village, he is met by a crowd of women and children, who rush out with shrill yells, bounding into the air and clapping their hands. They then form up around the traveler and escort him into the village, singing a chorus to the accompaniment of hand-clapping, some dancing along in front and calling out complimentary titles. Meanwhile, the chief and the men of the place assemble and sit down on the path awaiting the arrival. On reaching them, each turns over sideways and smacks his hip loudly several times with the hand. On meeting a native on the path, it is the custom for him to sit down on the ground and go through this performance. Near Feira, a black stands still as you approach and wipes his feet on the ground as if trying to get rid of a thorn.

I reached Feira August 4, and was most hospitably entertained by Mr. L. J. Tweedy, the Assistant Native Commissioner. The British post of Feira is prettily situated at the junction of the Loangwo River with the Zambezi. Across the river, at the foot of a steep mountain, are the ruins of Zumbo, once an important slave market. In the absence of the Administrator from the Portuguese post of Zumbo, a canoe was procured through the postmaster after some delay, and the trip down the Zambezi was commenced August 11. The Zambezi is one-half mile to one mile wide in these reaches, and has many shoals and sand banks. Crocodiles and hippopotami are numerous. Here and there low sandstone ridges extend down to the river, and mountain ranges are always in view. Very few native villages were seen on the river bank, and the whole district was still suffering from the effects of the rising in 1917, when the natives rebelled and destroyed most of the Portuguese posts and plantations.

About 30 kilometers below Zumbo is a station of the Zambezi Company, where a supply of chickens and rice was procured for food. A further two days' paddling brings one to Mague, and half a day beyond is the military fort of Cachomba. The river now narrows, running between steep hills and passing through a small gorge at Mount Manherere. The Cocolola Rapids are in this gorge, but the main channel of the river is clear and the run presents no special dfficulty. There is, however, an unnavigable stretch below Chicoa, where I arrived August 19. From Chicoa we traveled about 95 miles over a good cleared road returning to the river at Tete, the administrative center of the region. Rest-houses were found, and water courses were numerous, but many of them were already dry, and water was only obtainable from holes scooped in the sand.

We arrived at Tete August 27, and found the Portuguese most hospitable and helpful, as in fact we had found them wherever we met them along the route from Zumbo. The town is built on the side of a low sandstone hill sloping down to the Zambezi, and is well planned, with good roads and some fine buildings. River steamers ply to Chinde three times a month during the high-water season, but between September and December the river is very low and often there is no service. After completing the observations alongside the ruins of an old sun-dial constructed by Dr. Livingstone, the journey down river was continued by canoe to Chindio, the terminus of the Nyassaland Railway, whence there are frequent river steamers to Chinde. An unpleasant feature of the trip was the very powerful sun and the strong easterly winds which prevailed every afternoon, preventing the erection of a shelter against the sun's rays. In these reaches, as above Chicoa, the river is a mile wide, and has many shoals through which the crew must force the canoe. Some 30 miles below Tete is the Lupata Gorge, in which the river is hemmed by picturesque sandstone ranges for about 25 miles. At Bandar and Ankuaze, the district was infested by man-eating lions. A few days before our arrival at the former place, two lions had broken into a hut and eaten a native, and the villagers were consequently living in a state of terror. On two occasions lions were prowling around the camp at night. They did not attack, but, after roaring considerably, went away.

TABLE 18.

No.	Name[1]	Date	Latitude	Long. East
		1920	° ′	° ′
1	*Libreville, A*	Jan. 27	0 23.2N	9 27
2	*Port Gentil, 1920*	" 31	0 42.6S	8 46
3	*Boma*	Feb. 5	5 51.5S	13 04
4	*Matadi, 1920*	" 7–8	5 49.4S	13 28
5	*Banana, 1920*	" 10–11	6 00.4S	12 26
6	*Loanda*	" 16–18	8 48.8S	13 14
7	*Malange*	" 24	9 33.0S	16 21
8	*Cassoalala, 1920*	" 26	9 29.6S	14 22
9	*Loanda*	Mar. 1–3	8 48.8S	13 14
10	Loanda Observatory, *A, B*	" 10–12	8 48.8S	13 13
11	*Benguela*	" 16–17	12 34.6S	13 24
12	*Lobito, B*	" 19	12 20.5S	13 34
13	*Lobito, A*	" 22	12 20.9S	13 34
14	*Huambo, B*	Apr. 1–2	12 45.3S	15 47
15	*Huambo, A*	" 3	12 46.3S	15 46
16	Bela Vista	" 5	12 32.2S	16 17
17	*Xinguari*	" 7	12 33.1S	16 24
18	Camundongo	" 12	12 31.1S	17 08
19	Belmonte	" 15	12 21.8S	17 03
20	Chissamba	" 17	12 10.2S	17 25
21	Cuanza	" 20	11 55.0S	17 46
22	Rio Chiemba	" 23–24	12 02.8S	18 21
23	Munhango	" 26	12 11.5S	18 44
24	Lumeje	" 30	11 56.0S	19 32
25	Moxico	May 3	11 51.0S	20 03
26	Boma	" 4, 6	11 48.8S	20 09
27	Cazeze	" 13	11 32.4S	20 45
28	Chabaia	" 15	11 26.5S	21 04
29	Calengo	" 17–18	11 16.6S	21 32
30	Dilolo	" 21	11 30.0S	22 02
31	Rio Luambo	" 24	11 40.5S	22 34
32	Kavungo, *A*	" 27	11 31.5S	23 03
33	Kavungo, *B*	" 29, June 1	11 31.2S	23 02
34	Mwandeje	" 4	11 18.0S	23 28
35	Bumba	" 6	11 06.1S	23 50
36	Kalene Hill	" 9	11 11.0S	24 12
37	Musokantanda Plain	" 11–12	11 02.8S	24 40
38	Lufupa River	" 14–15	10 56.5S	25 02
39	*Ruwe*	" 17	10 40.7S	25 32
40	*Kambove*	" 22	10 52.8S	26 37
41	*Elisabethville*	" 30–July 1	11 40.0S	27 29
42	*Broken Hill*	" 9	14 28.1S	28 26
43	Livingstone	" 14, 16	17 51.2S	25 52
44	*Victoria Falls*	" 17	17 56.1S	25 51
45	Kafue	" 20	15 46.6S	28 12
46	Mbosa	" 26	15 54.8S	28 40
47	Shapanga	" 28	15 51.1S	29 07
48	Mburuma	" 31–Aug. 1	15 36.2S	29 40
49	Feira	" 5	15 37.4S	30 25
50	Panhame	" 12	15 37.2S	30 40
51	Captiva	" 14–15	15 43.7S	31 14
52	Cachomba	" 18	15 39.1S	31 55
53	Chicoa	" 20	15 36.2S	32 21
54	Mashambo	" 23	15 45.3S	32 53
55	Boroma	" 26	16 03.4S	33 27
56	Tete	" 30, Sep. 1	16 09.2S	33 35
57	Bandar	" 5–6	16 37.8S	34 10
58	Ankuaze	" 7	16 47.6S	34 34
59	Chemba	" 10	17 11.3S	34 55
60	Chindio	" 13–15	17 41.6S	35 17
61	Mopea	" 18	18 00.4S	35 42
62	*Chinde*	" 21	18 34.6S	36 28
63	*Beira, A*	" 28	19 49.4S	34 51
64	*Beira, B*	" 29	19 49.9S	34 51
65	Macute Point	" 30	19 51.0S	34 53

[1] The stations are located in the following countries: Nos. 1 and 2, French Equatorial Africa; Nos. 3 to 5 and 37 to 41, Belgian Congo; Nos. 6 to 35, Angola; Nos. 36 and 42 to 49, British South and Central Africa (Rhodesia); Nos. 50 to 65, Portuguese East Africa.

We arrived on September 21 at Chinde, which is a neat little town with several stores, two banks, and two hotels. There is a British concession and a consul. After reoccupying our magnetic station, a coastal steamer was taken to Beira, the work at that place being completed by October 1.

Table 18 shows the stations at which magnetic observations were made and the order of occupation. For values of the magnetic elements, see Table of Results.

The total time occupied in the work was 249 days, from January 27 to October 1, 1920. With 65 stations occupied the average field time per station is 3.8 days. The total distance traveled was approximately 5,000 miles. The average distance traveled between stations is 77 miles. The average cost was about $20 per station for field expenses.

A pronounced local disturbance exists at Bela Vista. Laterite occurs on the Bihe plateau, but after leaving the Cuanza River no rocks are seen and the road is often very sandy. An outcrop of laterite was noticed near Lumeje, and the Simoi River at Moxico flows through rocky hills of the same formation. From Moxico to Chabaia ferruginous rock (laterite) outcrops in several places, though the general formation is a white sand. The ironstone is sufficiently rich to be smelted, and the natives make spear heads and other implements from it. Beyond Chabaia the route leads across swampy flats and low ridges of hard sand, and no rock exposures were seen before reaching Nana Candundo (Kavungo), where some large boulders of granite are visible in the stream-bed below the mission station. As we proceeded eastward, natives were occasionally met carrying baskets of ironstone chips for smelting, but these were obtained from special localities. The observations indicated no local disturbance.

Kalene Hill is an escarpment of quartzite with outcrops of laterite at its base. Entering Katanga in the Belgian Congo, we find the country more hilly and very rich in copper. Quartz rock is very plentiful and some laterite, shale, and limestone are also found. The railway line from Elisabethvile to Livingstone, in Northern Rhodesia, passes through regions of pronounced local disturbance. Along the Kafue River the formation is dolomite. The hills recede at the junction with the Zambezi River, and the route leads along alluvial flats or crosses hills of sandstone and quartz with mica much in evidence. Sandstone was the general formation on the lower Zambezi, and in the Tete district granite, quartz, and limestone also occur.

The operations of the expedition were greatly facilitated by His Excellency the Governor General of Angola at Loanda, who supplied a general letter of introduction to all authorities in the Colony. Assistance and hospitality were extended by the British Consul at Lobito Bay, Mr. R. A. Duthie; by Mr. P. R. Mears; H. F. Varian Esq., Resident Engineer of Lobito Railway; Rev. W. C. Bell, and Dr. W. H. Sanders, and other members of the American Board Mission stations; Messrs H. W. Griffiths and F. Schindler and also Dr. W. Fisher of the English Brethren Mission; His Excellency the Governor General of the Belgian Congo also supplied a general letter of introduction which was of great material assistance. His Excellency the Administrator of Northern Rhodesia, Sir Lawrence Wallace, K. B. E., C. M. G., rendered valuable aid in the work in Rhodesia. Assistance and hospitality were also extended by Mr. L. J. Tweedy, Assistant Native Commissioner of the British post of Feira; by Sr. João Correa da Silva, the British Consul at Tete; and also by Sr. Raposa of Mopea.

Work in the interior of Angola is not practicable in the rainy season between December and March. Rest-houses are now being erected on the main routes, and a few motor roads have been constructed, so that it is possible to reach the Belgian frontier from Malange by motor in the dry season, April to November. A tent is necessary and also a camping outfit (chair, table, bath, etc.). Since they can not be procured in the country they should be brought from America or England. A mosquito net is an absolute neces-

sity. The interior of Angola is a plateau of considerable elevation where the weather is cold from April to August and at least 3 blankets are necessary, besides a supply of heavy clothing. A rifle and revolver are required for protection, not against the natives who gave no trouble, but against lions. Food generally is scarce in Angola and supplies must be brought from the coast. A water cask or water bag should be carried, for water is scarce in places. The Portuguese paper money (there is no silver or copper coinage in circulation) is accepted even in the most remote parts, though salt or calico are appreciated more. Fever and veldt sores appear to be the chief ills of the white man, and quinine should be taken every day (5 grains or 25 grams). A thorough survey of Northern Rhodesia is being made, and the survey sheets can be procured on application to the Survey Department at Livingstone.

G. F. DODWELL, ON MAGNETIC WORK IN SOUTH AUSTRALIA, 1914 TO 1918.

In 1914 arrangements were made by which the cooperation of Government Astronomer G. F. Dodwell was secured in extending the magnetic survey in parts of South Australia. In accordance with this arrangement magnetic observations have been made in different parts of the state by expeditions sent out by the South Australian Government primarily for other purposes.

The Musgrave Range Geological Survey Expedition[1] offered an excellent opportunity of obtaining a valuable series of magnetic observations in a part of the state not readily accessible, and it was accordingly arranged that the Government Astronomer should accompany the expedition during the second half of the journey, and should carry out a program of magnetic work supplementary to the general magnetic survey of Australia being carried out by the Department of Terrestrial Magnetism. The instrumental outfit for this work consisted of magnetometer No. 6, provided by the Department, Barrow dip circle No. 38, loaned by the Government Astronomer of New South Wales, a theodolite-compass for quick determinations of declinations, besides various astronomical instruments, barometers, thermometers, and miscellaneous accessories. The expedition left Adelaide in August 1914, and returned in December of the same year. Complete observations were made at stations Nos. 1 to 9 in Table 20.

The country traversed was very drought-stricken, most of the creeks not having run for the past 7 years. The scarcity of water hampered the expedition a good deal, so that the number of stations at which it was possible to obtain magnetic observations was smaller than had been anticipated. Cautionary warnings regarding the natives had been given, but no mishap or trouble occurred. Musgrave blacks had attacked previous expeditions, but during this one they had been driven back farther than usual by the drought.

In addition to the 9 complete stations, declinations were obtained at 20 places en route, using a trough compass-theodolite to which a solar attachment had been added, making it essentially a small equatorial instrument mounted on a theodolite base. This furnished a ready means of determining the meridian by pointing on the Sun, the declination then being obtained directly by the compass. The constant of the instrument was obtained from time to time by comparisons with the magnetometer. The errors of determination may be great, possibly amounting in some cases when the conditions were unfavorable to as much as one-half degree; the observations are, nevertheless, useful in showing that no great magnetic disturbances exist. Reports of other expeditions indicate the existence of highly magnetic rocks in certain localities, but none was found along the track of this expedition. The results of the compass observations are given in detail in Table 19.

During the years 1915 to 1918 the Government Astronomer made several journeys to points within 200 miles of Adelaide for the purpose of determining latitude and longi-

[1] See Bulletin No. 5, Appendix 11, Geological Survey of South Australia, Adelaide 1915.

TABLE 19.

Route station No.	Lat. South		Long. East		Date		Local mean time		Declination	
	°	′	°	′	1914		h	m	°	′
1	27	09	134	43	Sep.	10	7	55	3	46 E
2	27	09	134	27	"	10	17	22	3	38 E
	27	09	134	27	"	11	8	27	3	20 E
3	27	02	134	22	"	11	13	06	3	38 E
4	26	58	134	18	"	11	17	12	3	41 E
	26	58	134	18	"	12	8	26	3	50 E
5	26	56	134	02	"	13	7	57	4	01 E
6	26	57	133	54	"	13	13	56	2	55 E
7	26	56	133	47	"	13	17	26	3	30 E
	26	56	133	47	"	14	8	06	3	44 E
8	26	55	133	37	"	14	12	35	3	29 E
9	26	58	133	28	"	15	7	49	3	33 E
10	26	59	133	20	"	19	8	10	3	24 E
11	26	56	133	12	"	19	17	48	3	11 E
	26	56	133	12	"	20	7	33	3	31 E
12	26	53	133	06	"	20	13	29	3	36 E
13	26	57	133	16	Oct.	4	7	24	3	45 E
14	27	20	133	27	"	14	12	47	3	47 E
15	27	35	133	51	"	16	7	20	3	56 E
16	27	41	134	04	"	18	7	29	3	52 E
17	27	46	134	19	"	25	7	21	3	17 E
18	27	46	134	32	"	25	17	52	3	35 E
	27	46	134	32	"	26	7	02	3	40 E
19	28	05	135	05	"	29	8	04	4	00 E
20	28	13	135	26	Nov.	1	7	00	4	00 E

TABLE 20.

No.	Name	Date	Lat. South		Long. East	
		1914	°	′	°	′
1	Todmorden	Sep. 7–8	27	08.5	134	45
2	Wantapella	" 17, Oct. 10	27	00.9	133	28
3	Moorilyanna	" 25, " 1	26	52.2	133	01
4	Moorilyanna, Secondary	Oct. 1–2	26	52.5	133	01
5	Marble Well	" 16	27	33.1	134	00
6	Stanley's Well	" 22–23	27	42.6	134	07
7	Christlieb Well	" 27	27	57.2	134	46
8	Raspberry Creek Bore	" 30	28	08.2	135	05
9	Nilpinna	Nov. 3–4	28	13.1	135	42
		1915				
10	Roseworthy	Sep. 6–7	34	32.0	138	45
11	Gawler	Dec. 16–17	34	37.1	138	44
12	Angaston	" 21	34	30.5	139	03
13	Kapunda	" 23	34	20.4	138	55
		1916				
14	*Border Town*	May 26–27	36	18.5	140	46
15	Naracoorte	" 29–30	36	57.0	140	45
16	Wilmington	Sep. 2, 5	32	39.3	138	05
17	Melrose	" 12, 13	32	48.4	138	12
18	Booleroo Center	" 20–21, 23	32	53.0	138	21
19	Penola	Dec. 20–21	37	22.6	140	50
		1917				
20	Robe	Feb. 26–27	37	09.8	139	45
21	Long Gully	" 28	37	18.2	139	50
22	Kingston	Mar. 6	36	49.8	139	51
23	Kybybolite	May 16–19	36	53.2	140	55
		1918				
24	Nairne	Jan. 9–10	35	02.4	138	54
25	Goolwa	" 16–18	35	30.0	138	47
26	Port MacDonnell	Feb. 12, 14	38	03.4	140	42
27	Mount Ruskin	" 25–26	38	03.0	140	58

tude, and magnetic observations were made on these journeys as opportunities permitted. Late in 1915 he established 4 stations at points northeast of Adelaide, and in May 1916 two more, Border Town and Naracoorte, the former being a proximate reoccupation of the C. I. W. stations of 1911 and 1914. In the 1915 stations Dover dip circle No. 226 was substituted for Barrow No. 38; at the two 1916 stations mentioned Professor Kerr Grant, of the Adelaide University, and Mr. R. S. Burdon assisted in making the observations. Later, in September of the same year, 3 stations were occupied near the head of Spencer Gulf, while the last 9 stations of the series were occupied in connectoin with latitude and longitude work in the extreme southeast portion of the state near the Victoria boundary. Professor Grant also assisted in this last series of observations. In Table 20 (see p. 153) the names and geographic positions of stations occupied in years 1914 to 1918 are given; for magnetic elements, see Table of Results.

C. K. EDMUNDS, ON MAGNETIC WORK IN CHINA, JANUARY 1915 TO JULY 1917.

In November 1914, plans for expeditions in western China were approved and authorization for alterations and extensions of these plans was made from time to time by written or cabled correspondence with the Director as occasion arose. In the execution of this work, Mr. Frederick Brown was assigned at the conclusion of the Australian campaign to work under my supervision as chief of party. He continued under this arrangement until July 1917, after which he reported directly to Washington.

Mr. Brown arrived at Canton on January 13, 1915, and intercomparisons of the instruments brought by him with those used by me in recent work were at once begun. These included full determinations of instrument and station-differences for magnetometers Nos. 12 and 17, 12 and 9, and dip circles Nos. 206 and 177, 206 and 172, and 172 and 177. The station-difference was determined not only between the new hut-stations, A_s and B_s, on the grounds of the Canton Christian College, but also between the former hill station, Canton 3, and hut station, A_s. Magnetometer No. 17 was returned to Washington on completion of its comparison with No. 12. Mr. Brown's remaining magnetometer No. 9 and dip circle No. 177 were then compared with the instruments of the Royal Observatory, Hongkong, through the courtesy of T. F. Claxton, Director. These comparisons occupied from January 13 to March 20. On March 23, Mr. Brown accompanied by Mr. N. K. Ip and a cook, left Canton for a trip through the four provinces, Kwangtung, Hunan, Kweichow, and Kwangsi, and on his return in July a further and full intercomparison of magnetometers Nos. 12 and 9 was carried out. During his absence, I had completed plans for the future work of the two parties, and at intervals during January to July, inclusive, had made a number of full daylight periods of diurnal-variation observations in declination.

During August the parties were transferred north, and while en route to Peking they observed at 6 or 7 places that fill gaps left in former campaigns. This report covers in detail only the field work executed by myself; that done by Mr. F. Brown is covered by his own separate reports. My instrumental equipment consisted of the following: theodolite-magnetometer No. 12, with thermometers; dip circle No. 206, with compass attachment, dip needles Nos. 1 and 2 of dip circle No. 206, Nos. 5 and 6 of dip circle No. 178, and intensity needles Nos. 3 and 4 of dip circle No. 206; Glover box chronometer No. 558 (not used after December 22, stolen by armed bandits February 20, 1916); 2 pocket chronometers; 4 watches; hypsometer with thermometers; aneroid barometer; vest-pocket and Graflex cameras; observing tent and its accessories.

From Shanghai, where Mr. Brown, accompanied by Mr. Ip, left me for a detour in Shantung by boat down the Yellow River and back by cart to the railroad, after a day devoted to official correspondence and arrangements, I proceeded by rail direct to Tientsin, arriving August 11, midnight. August 12 was devoted to arranging for the

delivery of supplies and transport equipment that had been ordered from America, conferring with the American Consul, visiting the site of my former station (1907), which was found no longer available, and engaging a cook for Mr. Brown to use later. On August 13, I left Tientsin at noon by rail for Tangshan, which was the first station occupied in this campaign.

My field work proper may be regarded as in two major divisions separated by a brief return to Canton in May 1916. The first period began at Tientsin, August 13, 1915, and ended at Hankow, May 9, 1916. This may be regarded as including four principal parts: (a) a loop in northeast Chihli and Inner Mongolia beginning and ending at Peking, (b) a line from Peking generally westward to the Yellow River at Paotehchow, (c) a traverse west and south from the northeast quarter of Shensi to the southwest quarter of Szechwan, (d) the descent of the Yangtze Kiang. The second division, brief compared with the first, began at Tientsin, July 6, 1916, and ended at Hankow, September 12, 1916. This consisted of: (a) an overland journey from the rail end at Tatungfu in Shansi to the Yellow River at Hokow, (b) the descent of the Yellow River from Hokow to Tungkwanting, (c) an overland journey from Tungkwanting to Kingtzekwan on a tributary of the Han River in Honan, (d) the descent of the Han.

Although most of the latter part of August 1915 was spent at Peking in making the necessary arrangements for the expeditions of Observer F. Brown and myself to travel separately in both China and Mongolia, advantage was taken of the delays incident to such negotiations to observe at Tangshan, Peking, Nankow, and Kalgan, all in Chihli, and all reached by rail, the last three being also stations at which Fritsche observed about 40 years ago. I had occupied Peking also in October 1907. In the meantime Mr. Brown finished the work in Shantung previously referred to, and rejoined me at Kalgan on September 1, 1915.

At Kalgan, supplies and equipment were secured and divided between the two parties, and arrangements for transport were made. Rev. Magnus Johansson, a Swedish missionary to the Mongols, was assigned as interpreter-companion to Mr. Brown, and Mr. Ip was assigned to travel with me as mandarin-interpreter and general assistant. During the week spent at Kalgan on the preparatory work, the party were the guests of the British and American Tobacco Company, whose representatives extended every possible courtesy and help. On September 8, 1915, Messrs. Brown and Johansson left Kalgan for Urga in Mongolia. See Mr. Brown's separate account of this campaign.

Leaving Kalgan, September 6, 1915, I traveled with carts northeasterly to Dolonnor and thence southeasterly to Jehol, observing at 7 stations, including Kalgan, in Inner Mongolia, now politically considered as part of Chihli Province. From Jehol (or Chengtehfu), which was formerly the Mongol and Manchu capital and is a station of Fritsche, I descended the Lwan River to a point within the Great Wall almost due east of Peking, and thence with carts traveled overland to Peking, observing at four intermediate stations.

Peking was reached October 10, and after a week spent in making further arrangements in connection with Mr. Brown's work as well as my own, I proceeded to Paotingfu by rail and thence traveled with pack mules generally northwest across Chihli and Shansi provinces and attained the Yellow River at Paotehchow, November 15, observing at 13 stations in all, from Peking to Paotehchow inclusive. The special feature of this route was the number of Fritsche stations reoccupied. Four were reoccupied on this last stretch of my journey, which makes a total, from August to November 1915, of 11 Fritsche stations at which observations were made, namely, Peking, Nankow, Kalgan, Urga (Mr. Brown), Jehol (Chengtehfu), Tuanchialing, Tungchow, Paotingfu, Futuyü, Tuanyuantsun, and Pekow.

From Paotehchow the Great Wall was followed along the south side of the Ordos Desert to Yulinfu, thence the party traveled generally southward to Sianfu, where

Sower's station of 1909 was reoccupied, December 22. Leaving Sianfu December 28, the party continued with pack mules, west and south to Kwangyüan in Szechwan thence to Lunganfu via Pikow in Kansu. From Lunganfu the mules were sent southward toward Chengtu, while the observer, with instruments carried by men, crossed the Süehshan Pass (13,138 feet) to Sungpan, and thence followed the Min River to Kwanhsien. This route is practically along the Tibetan border, although considerable territory west of the river is now regarded by the Chinese as politically within Szechwan Province.

Chengtu was reached March 2, 1916. On March 13 the party started southwest for Yachowfu and thence came generally eastward to Chungking on the Yangtze River which was reached April 8, 1916. In the course of this journey observations were made on the summit of Mount Omei (10,000 feet), which apparently exhibited a marked local magnetic disturbance.

At Chungking the mules were released as further travel was to be by boat. The American Consul at Chungking, the late C. P. McKiernan, most courteously entertained the party and was very useful in helping the expedition forward. April 13, 1916, the party left Chungking by houseboat, and descended the Yangtze to Ichang, which was reached April 25. From Ichang we proceeded to Hankow by steamer, observing en route at Shansi and Yochow. After reoccupying my former station at Hankow, I left on May 9 by steamer for Canton, attending to computation and correspondence as I traveled. After 10 days at Canton devoted to affairs of the Canton Christian College, I returned direct to Peking to meet Mr. Brown and arrange for future work.

During the campaign thus briefly reviewed, 79 stations were occupied, two of them being repeat stations, rather evenly spaced along a crooked line which stretches completely across China from the Mongolian border on the northeast to the Tibetan border on the southwest and thence down the Yangtze to the approximate center of China. Of these, 40 (counting Peking only once) were occupied during the last five months of 1915 and 39 during the first five months of 1916. The distribution of these is as follows: 21 in Chihli (7 in Inner Mongolia), 5 in Shansi, 14 in Shensi (4 on southern border of the Ordos), during 1915; and during 1916, 7 in Shensi, 1 in Kansu, 26 in Szechwan (6 along the Tibetan border), 4 in Hupeh, 1 in Hunan (the last 10 along the upper Yangtze Kiang).

Extended series of observations of magnetic declination were made on the first and fifteenth of each month, except on February 15 and March 1, 1916, when the disturbed condition of the country made it wisest not to delay, and on May 1, 1916, when heavy rains prevailed. During most of this period the country was in a disturbed state, especially the provinces of Shensi and Szechwan, and travel was rather difficult. The officials everywhere did what they could to afford protection, and although threatened several times and once actually overcome by brigands, the party came through without any really serious mishaps.

The second major division of the 1916 campaign in China may be said to begin with my meeting Mr. Brown in Peking on June 8 and arranging the program for the rest of the year so far as the uncertain political conditions permitted. Our original plans for an extensive survey in northwest Mongolia had to be indefinitely postponed because of failure to secure from the Russian Government permission to traverse portions of Siberia in reaching and leaving the desired field. Consequently, it was decided that Mr. Brown should devote July, August, and September 1916 to observing throughout Manchuria at points on the various railway lines, while I should, in the same interval, traverse northern Shansi westward from Tatungfu to Hokow on the Yellow River, and descend the latter to Tungkwanting, thence travel overland southward to the basin of the Han River, and finally descend the latter to Hankow.

By October 5, Mr. Brown had completed the Manchurian work, adding 6 Fritsche stations to those already reoccupied by our expeditions; he then proceeded direct to Chungking in Szechwan, and started on an expedition south and west across Yunnan to the Burma border.

The details of my own expedition are as follows: Accompanied by Mr. H. J. Fairburn of the English Baptist Mission at Sianfu as interpreter-companion, I left Pehtaiho on July 5, 1916, after a few days' official conference with Mr. Brown, and traveled by rail to Tatungfu, in Shansi, arriving there Saturday, July 8, at sunset, having spent 2 days in Tientsin purchasing supplies, effecting repairs, etc. We left Tatungfu at 10 a.m., July 10, with pack mules, and reached Hokow on the Yellow River at noon on July 19. At Hokow there was considerable difficulty in hiring a boat owing to martial law prevailing along the river which is the boundary between Shensi and Shansi provinces along the stretch considered. Shensi had not yet recognized the new government at Peking. The boat guild also held out for a big price, which we had finally to pay. We left Hokow on July 23 and arrived at Tungkwanting August 10, 1916, having observed at 8 stations on this north-south stretch of the Yellow River. From Tungkwanting the party came by cart and pack mules to Kingtzekwan in Honan, situated on a tributary of the Han River, by which we reached Hankow September 9, at midnight.

From Tientsin to Tungkwanting my party included Mr. R. E. Baber of the Canton Christian College, whose share of road expenses was covered personally. He assisted heartily in the work of the expedition, and his presence added to the security of the party in traversing a disturbed region.

From Hankow I went direct to Peking by rail (September 12–13, 1916) to arrange for Mr. Brown's further work. I also embraced this opportunity to report in person on the work of the Department in China to His Excellency, President Li Yuan Hung, and to the Honorable Chen Chin-tao, Minister of Finance, then acting also as Minister of Foreign Affairs. Both expressed sincere appreciation of our work, the published reports of which had already been transmitted to the Chinese Government.

The details of arranging for Mr. Brown's further work necessitated such delay that during the latter half of September I took advantage of this circumstance to enjoy a needed holiday until October 1. Mr. Brown joined me at Pehtaiho on October 5, 1916. Comparisons of my dip circle No. 206 with his No. 177, which had suffered a fall in Manchuria in August, were made on October 5–7. Circle No. 206 was forthwith given to Mr. Brown to replace No. 177. On October 21, I left Shanghai by rail, where I arranged through the courtesy of the Zikawei Observatory and Admiral Winterhalter, commanding the U. S. Fleet in Asiatic Waters, for the transmission of time signals by wireless to Mr. Brown at Hankow. These were sent by the French wireless land station in direct communication with the Observatory and were received at Hankow by the U. S. S. *Monocacy*. At the end of these experiments, which were only partially successful, owing to low power of the apparatus on the *Monocacy*, I left Shanghai October 30 by steamer for Canton, arriving there November 3, 1916. Since then I have given such time to the Department's affairs as the supervision of Mr. Brown's work and expedition required. On April 11, 1917, I left Canton for Hongkong, and sailed for the United States April 12 on the *Empress of Asia*.

The magnetic field in the regions covered is quite regular and of small declination throughout, varying from 0° to 5° W of N. A marked local disturbance seems to be indicated by the observations on the summit and near the base of Omeishan in Szechwan, but more data are needed. The local disturbance indicated by Fritsche's observations in Chihli at Futuyü (8° 13′ W) and at Pekow (2° 02′ E) was not verified, the generally prevailing field of about 3° W being found to obtain at these places also.

TABLE 21.

No.	Name[1]	Date	Lat. North		Long. East	
		1915–16	°	′	°	′
1	Tangshan	Aug. 13–14	39	37	118	09
2	*Peking*	" 20	39	56.6	116	25
3	Nankow	" 30	40	14	116	09
4	Kalgan	Sep. 1–3	40	51	114	51
5	Panshantu	" 8	41	19.5	114	59
6	Pingtinobo	" 10–11	41	41	115	39
7	Dolon-nor	" 14–15	42	10	116	23
8	Kuanti	" 18	41	48.3	116	54
9	Fengning	" 20	41	14.1	117	07
10	Chengtehfu	" 25, 27	40	59	117	52
11	Shahokiao	" 29–30	40	20	118	13
12	Tsunhwachow	Oct. 1–2	40	11	117	56
13	Tuanchialing	" 5	40	00.7	117	08
14	Tungchow	" 6–7, 14	39	54.7	116	36
15	*Peking*	" 15	39	56.6	116	25
16	Paotingfu	" 18–20	38	50.6	115	33
17	Kaopeitien	" 20–21	39	19	115	55
18	Liangkochwang	" 21–22	39	21	115	26
19	Futuyü	" 25	39	22	114	51
20	Tuanyuantsun	" 26–27	39	32	114	41
21	Hanshihling	" 27	39	40	114	39
22	Pekow	" 28–29	39	45	114	38
23	Wanghuo	Nov. 1–2	39	49	113	57
24	Yingchow	" 5–6	39	33.7	113	10
25	Sochow	" 9	39	19.0	112	22
26	Wüchai	" 12	38	55.2	111	45
27	Paotehchow	" 16–17	39	01.4	110	56
28	Haichalu	" 22	38	42.4	110	25
29	Encampment	" 24	38	33.1	110	00
30	Yulinfu	" 26	38	06	109	14
31	Micheh	" 29–30	37	40.8	109	52
32	Suitehchow	Dec. 1–2	37	29.8	110	02
33	Erhshihlipu I	" 4	37	02.5	109	57
34	Yenmunkwan	" 6	36	47.7	109	49
35	Yenanfu	" 8	36	33	109	21
36	Matszchi	" 10	36	14.8	109	20
37	Fohlokchuan	" 13	35	42.3	109	21
38	Chengsokwan	" 15–16	35	13.4	108	57
39	Sanyüanhsien	" 18	34	36	108	58
40	*Sianfu*	" 22	34	16.3	108	57
41	Tungfufeng	" 30	34	17	108	14
42	Kishan, *A*, *B*	Jan. 1	34	19	107	29
43	Kwanyintong	" 4	34	03	106	49
44	Fenghsien	" 7	33	53	106	33
45	Liupating	" 10	33	38	106	59
46	Erhshihlipu II	" 12	33	22	107	00
47	Hanchungfu	" 14–17	33	05.2	107	05
48	Taianyi	" 20–21	33	08	106	08
49	Tumuntsz	" 24	32	39.3	106	00
50	Kwangyüan	" 26	32	26	105	51
51	Paishuiho	" 29	32	40	105	32
52	Pikow	" 31–Feb. 1	32	44.7	105	18
53	Chingchun	Feb. 4	32	24	105	00
54	Lunganfu	" 5, 7	32	22	104	36
55	Shuichingchan	" 8–9	32	29.2	104	22
56	Lautangfong	" 12	32	34	103	56
57	Shanchatsz, *A*, *B*	" 14	32	45	103	52
58	Sungpan	" 16	32	39.2	103	46
59	Shawan	" 19–20	32	04.5	103	40
60	Tsunchü	" 23	31	38.5	103	44
61	Weichow	" 25	31	27	103	29
62	Kwanhsien	" 29	30	58.4	103	33
63	Chengtu	Mar. 6–7	30	38.0	104	03
64	Kiungchow	" 15–16	30	24.1	103	25

[1] The stations are in the following provinces: Nos. 1 to 22, Chihli; Nos. 23 to 27, 81 to 85, and 87 to 90, Shansi; Nos. 28 to 48, 86, and 91 to 93, Shensi; Nos. 49 to 51 and 53 to 75, Szechwan; No. 52, Kansu; Nos. 76 to 78, 80, and 95 to 98, Hupeh; No. 79, Hunan; No. 94, Honan.

TABLE 21—*Concluded.*

No.	Name	Date	Lat. North		Long. East	
		1916	°	′	°	′
65	Yachowfu	" 18–19	29	58.8	102	56
66	Omeishan	" 24–25	29	31.8	103	16
67	Kiatingfu	" 27	29	33.3	103	41
68	Junghsien	" 30	29	27.7	104	22
69	Tzeliutsing	" 31–Apr. 1	29	22	104	42
70	Tungchingwan	Apr. 6	29	24	105	45
71	Chungking	" 10–11	29	33	106	33
72	Fowchow	" 15	29	41.8	107	24
73	Chungchow	" 17	30	17.1	108	03
74	Wanhsien	" 18	30	48	108	25
75	Kweichowfu	" 22	31	01	109	34
76	Patung	" 24	31	02.3	110	25
77	Ichang, *A*	" 26	30	43.3	111	18
78	Shasi	May 1	30	16	112	17
79	Yochow	" 4–5	29	27.1	113	12
80	*Hankow*	" 9	30	36.4	114	20
81	Hungtuling	July 13–14	40	05.0	112	23
82	Tsingshuiho	" 17	39	54.8	111	39
83	Hokow	" 19–20	40	14.4	111	05
84	Laoniuwan	" 24–25	39	38.6	111	19
85	Shihtszkou	" 28	38	58	110	54
86	Liuchauwan	" 29	38	26.4	110	43
87	Chikow	Aug. 1–2	37	38.5	110	40
88	Nantsuitsa	" 3	37	01.2	110	17
89	Lungwangchan	" 5	36	10.1	110	20
90	Island (Hwang Ho)	" 8	35	25.4	110	25
91	Chingkuoping	" 14–15	34	29.0	110	00
92	Shangtsuan	" 21–22	34	03	110	09
93	Lungchüchai	" 24	33	41.0	110	15
94	Laojentsang	" 30	32	58.9	111	18
95	Laohokow	Sep. 1–2, 4	32	23.2	111	38
96	Ichenghsien	" 5–6	31	44.0	112	15
97	Anlu	" 7	31	10.7	112	35
98	Tatzekow, *A*, *B*	" 8	30	23	112	51

Table 21 (see pp. 158–159) gives the names of the stations on my own expedition, with dates and geographic positions; for values of the magnetic elements, see Table of Results. For Mr. Brown's stations, see his separate reports.

The total time devoted to the campaigns herein reviewed (including my attention to Mr. Brown's work) was 14½ months, of which 10 days were devoted to intercomparisons of instruments, 35 days to travel outside of the immediate field (most of this time, however, was devoted to computation and correspondence), and about 40 days (the total of five sojourns in Peking during August and October 1915, June, September, and October 1916) to the slow task of negotiations and official arrangements. Most of this period was spent in behalf of Mr. Brown's work rather than my own.

The total time devoted to my actual expeditions in the field was about 350 days. Omitting the time devoted to Mr. Brown's expeditions, which can not properly be included in these estimates, the average total time per station has been 4 days, and the average field time per station has been between 3 and 4 days. The total distance traveled to and from Canton was 6,600 miles. The distance traveled in the local field was 6,057 miles. Accordingly, the average total travel per station was 129 miles, and the average field travel per station was 62 miles. The total cost (exclusive of expenses incurred in connection with the supervision of Mr. Brown's expeditions) was about $2,610, of which about $450 was for transportation, subsistence, and incidentals in connection with travel of self and recorder from and to Canton, leaving $2,160 as the expense incurred in the local field proper. Accordingly, the average total expense per station was $27 and the average field expense per station $22 approximately.

As heretofore, too much can not be said of the kindness and help extended to the party by missionaries wherever we met them. The Hon. F. D. Cheshire, American Consul-General at Canton, has been very helpful in arranging for traveling permits of unusual range. Throughout, the very efficient Chinese postal service was relied on for the transmission of money as well as mail, and I wish to express appreciation of the good offices of Commissioner Shields of Kwangtung and Commissioner Parkin of Kweichow, who have been helpful in affording special facilities for transfer of money and parcels and in suggestions as to routes and methods in the work contemplated. Commissioner Smith at Sianfu, Commissioner Doodha at Chengtu, and Commissioner Hyland of Tientsin deserve commendation for the special attention they have given to our affairs. We desire also to acknowledge our obligation to the American Legation for its good offices, and to the American consuls at the principal cities visited for valuable cooperation.

A. L. KENNEDY, ON MAGNETIC WORK IN SOUTH AUSTRALIA, APRIL TO JULY 1914.

The expedition in South Australia was organized under instructions from my chief of party, Mr. E. Kidson, dated April 2, 1914. I left Adelaide April 6 by rail for Farina with the following instrumental equipment: theodolite-magnetometer No. 9, Barrow dip circle No. 41 (loaned by the Melbourne Observatory), 2 pocket chronometers, 2 watches, tent, and miscellaneous small items.

An Afghan camel driver was engaged at Farina, and a caravan of 5 bull camels, with which we started April 13 for Mount Hopeless Bore. The journey of 137 miles led through sheep stations and generally over well-grassed, slightly hilly land. Traveling was good except in the vicinity of Lake Crossing Bore, where there are several miles of heavy sand.

From Mount Hopeless Bore to Innamincka, 163 miles, the track is mainly along the bed of the Strzelecki Creek. The road is fairly level but very sandy, and winds in and out between rows of drifting hills of red sand. The creek bed is well timbered, and generally affords plenty of camel feed. Wells and water-holes are found at easy stages. The 5 camels wandered off in the night at Innamincka, and we were delayed in consequence 7 days searching for them. By good fortune, we found 3 strange camels in the bush country, with which I decided to continue the journey, although it necessitated abandoning some of the supplies and only allowed us one camel for riding.

Along the 36 miles between Innamincka and Patchawarra, feed is scanty. The track is level, with alternate stretches of sand and stones. Heavy rains delayed us here 9 days, and the Afghan camel man utilized the time searching for the 5 lost camels. I found later, on arrival at Hergott Springs, that they had returned home, thus saving trouble and expense. The distance from Innamincka, where they were lost, to their home, Hergott, is about 200 miles direct. From Patchawarra to Cordillo Downs, a distance of 50 miles, the road traverses many clay-pans and sand-hills. These clay-pans were flooded after the recent heavy rains, which made traveling difficult. From Cordillo Downs to Haddon Downs, 36 miles, the road crosses ranges of stony hills, and is very rough for the camels' feet. From Haddon Downs to Birdsville, the character of the country changes from level well-grassed plains to huge drifting sand-hills, while the flood areas of the Diamentina Creek again make the going difficult near Birdsville. We lost the track here, and wandered about 10 miles before we regained it.

The road from Birdsville to Hergott Springs, 330 miles, is well defined, and is used as a cattle trail, hence there is little feed for camels. The road bed is alternate stretches of stone and sand and crosses many drifting sand-hills and dry creek-beds. There was one stage of 50 miles without water between Carthole Water-Hole and Goyder's Lagoon Water-Hole.

Table 22 shows the magnetic stations, dates of occupation, and geographic positions; for magnetic elements, see Table of Results.

TABLE 22.

No.	Name	Date	Lat. South		Long. East	
		1914	°	′	°	′
1	*Farina, A*	Apr. 9–10	30	04.4	138	17
2	Mount Lyndhurst	" 15	30	11.0	138	42
3	Murnpeowie	" 19	29	35.3	139	03
4	Mount Hopeless Bore	" 23–24	29	36.4	139	45
5	Carraweena	" 26–27	29	11.0	139	59
6	Murta Murta Well	" 29–30	28	36.7	140	17
7	Nappacoongie Well	May 2	28	11.8	140	30
8	Innamincka, 1	" 5–6	27	45.5	140	44
9	Innamincka, 2	" 12	27	45.7	140	44
10	Patchawarra Well, 1	" 16	27	20.9	140	41
11	Patchawarra Well, 2	" 20–21	27	20.9	140	41
12	Cordillo Downs	" 27–28	26	42.9	140	38
13	Haddon Downs	" 31	26	21.0	140	50
14	Cadelga	June 3	26	05.5	140	24
15	Miranda	" 6	26	03.9	139	52
16	Birdsville	" 9–10	25	54.3	139	21
17	Carthole Water-Hole	" 12	26	20.9	139	15
18	Goyder's Lagoon	" 15–16	26	56.7	138	57
19	Mount Gason Bore	" 18–19	27	20.2	138	45
20	Mirra-Mitta Bore	" 21	27	43.7	138	44
21	Ooroowilanie Reservoir	" 24	28	17.0	138	40
22	Etadunna	" 27	28	43.1	138	38
23	Clayton Bore	" 30	29	16.8	138	23
24	*Hergott Springs*	July 5	29	39.4	138	03

We left Farina April 13 and arrived at Hergott July 2. The average field time per station (22 stations) was 3.7 days. The average cost per station was $27.07.

The great part of the area traversed is a lower and upper cretaceous deposit of sand, sandstone, quartzite, jasper, etc. There are extensive areas of land covered with desert sandstone boulders, locally known as "gibbers," which consist mainly of sandstone indurated by siliceous infiltrations. Most of the "gibbers" are red, coated with oxides of iron, the outcome of arid conditions. These oxides apparently have little effect on the magnetic conditions.

Mr. F. Budge of Farina, representing J. W. Manfield and Company, rendered great assistance in planning the journey. Mr. W. N. Johnston, manager of Patchawarra Bore, helped in every way possible to recover the 5 lost camels.

A. L. KENNEDY, ON MAGNETIC WORK IN SOUTH AUSTRALIA AND WESTERN AUSTRALIA, AUGUST TO OCTOBER 1914.

Preparations were made for a camel expedition from Port Augusta to Kalgoorlie, according to instructions from my chief of party, Mr. E. Kidson, dated April 2, 1914. Excepting the substitution of Kew dip circle No. 177 for the Barrow No. 41, the same instrumental outfit was taken as was used in my expedition in South Australia, April to July 1914.

After having made all arrangements to obtain 12 camels, 1 riding saddle, 9 pack saddles, 4 eighteen-gallon water-kegs, 2 boxes, etc., from the Engineer-in-Chief of South Australia, I engaged Tom Dare as camel driver, and sent him from Adelaide to the Government Depot at Hergott Springs on July 17 to receive the camels from Mr. J. G. Macdonald, in charge of the depot, and drive them to Port Augusta. I left Adelaide August 4, going direct to Port Augusta, where I reoccupied the magnetic station previously established by Government Astronomer G. F. Dodwell, of South Australia.

Mr. Dodwell, who took a kindly interest in our expedition, personally assisted in the observations, of which a complete series was obtained August 7.

On August 11, Dare arrived at Port Augusta with the camels, which appeared to be, on inspection, a fine strong lot, in excellent condition. However, we anticipated much trouble, for all had been wagon camels, and only 4 had ever carried packs. I ordered 7 new pack saddles to be made, those supplied with the camels not being the most suitable for our purposes. Discouraging information was received about the scarcity of water throughout the country, and we were advised by the experienced not to attempt the journey in such a bad season.

On August 19 I left Port Augusta with the saddles and boxes which had been finished, and ordered the remainder to be sent out by construction train to the rail-head through which we would pass, 113 miles from Port Augusta. Trouble with the camels was experienced immediately. They persistently threw their loads, and broke away, bolting through the scrub. However, by hard work on the part of my companions, we were enabled to make some progress each day. The camels finally settled down to the unaccustomed work after a lot of training. Camel feed was very poor all the way to the rail-head, and water scarce, most of the wells and dams being quite dry. View 3 of Plate 4 shows the party en route along Eucolo Creek.

At the rail-head I received the remainder of the saddles, boxes, and supplies by train from Port Augusta, and also learned that Kychering Soakage, some 25 miles west of Tarcoola, had run dry for the first time since white men have known it, and Wynbring Rock-Hole, 60 miles from Tarcoola, was also empty. The railway survey camp was being supplied with water by a string of camels continuously working from Carnding Well, a distance of some 90 miles. Feed for the camels was a little better between the rail-head and Tarcoola, but water was scarce, and some of the wells were too salty for drinking purposes. Having arrived at Tarcoola on September 7, I found that there was no water for stock or camels in the town. Water for drinking purposes was being carted from Caladding Rock-Hole, 7 miles north, at a cost of \$4.50 per hundred gallons. The government well in the township was quite dry. We finally rigged up a whip over a disused mine shaft and obtained fair water for the camels, containing 1¾ ounces of salt to the gallon. For the use of the party, I obtained a few buckets of fresh water from the police and eked it out with the stock-water.

A prospecting party under Hannan and McKenzie had been forced back into Tarcoola by the parched nature of the country. They confirmed the report that Kychering and Wynbring were dry, and also reported that Ooldea Water, 160 miles west of Tarcoola, was running short. They advised me to abandon the journey under the circumstances. However, the camel driver of the railway survey who had been to Ooldea some months before was positive that Ooldea Water could not run short. I took his advice and decided to proceed to Carnding Well, 28 miles northwest from Tarcoola, water the camels and fill the kegs, and push on to Ooldea, a waterless stage of about 155 miles by the Carnding Well route.

At Tarcoola I stayed 3 days to give the camels a rest, while I observed and computed. Feed was fair. On the night of September 8, 0.57 inch of rain fell, and gave us hope that some water would be caught in the Wynbring Rock-Hole. William Crook, a lad, was engaged to accompany us for the remainder of the journey, as I found that a fourth man expedites the work of camp.

The party left Tarcoola September 11, and proceeded via Caladding Rock-Hole, where we obtained good drinking water, to Carnding Well. The country was thickly covered with stunted scrub, myall, wild peach, mulga, and sandalwood, all, however, in a parched state. At Carnding the camels were watered and the kegs refilled, and the party left on September 14, heading southward through the scrub. We reached

the cut line of Walter's survey for the railway line at the 91-mile peg from Kingoonyah, and followed this to Wynbring Rock-Hole. We arrived there September 15, and found that the recent rain had put some water in the main hole. Some smaller rock-holes had water in them, but those large ones reported by Furner on his preliminary survey to have been cleaned out now contained dead dingoes, and water green and unfit to drink. One large rock-hole contained the body of a camel which had perished in attempts to obtain water. Feed was fair, and the country was thickly timbered with small myall and black oak somewhat wilted by the drought. Wynbring main rock is a dome-shaped granite outcrop 400 yards around and about 30 feet high. The main rock-hole is a cleft 25 feet long and 4 feet wide at the widest part. The water stood at 3 feet 6 inches below high-water mark.

The camels' backs had begun to show signs of bruising, owing to the bumping of the loads against trees. I ordered the loads of those in the worst state to be transferred to 2 riding camels. From then onward we had only one riding camel amongst the four of us, which entailed much walking. On September 17, we watered the camels and set out for Ooldea Water, a distance of 110 miles.

On September 19, I met Mr. Chalmers, who was making the survey for a railway. He stated that feed was poor to Ooldea, where it was good, there being much parakelia plant in that place; and that there were several areas containing poison bush to be avoided on the road.

At a point 56½ miles east from Ooldea Bore, observations were obtained. The camels arrived at Ooldea Water, a small soakage 4 miles north of the bore (the latter water containing 5 ounces of solids to the gallon), on September 20, at 11.30 p.m., having traveled 34 miles that day. We had accomplished, by a series of forced marches, the 110 miles of waterless track in 4 days, the latter part of the journey being over heavy sand-hill country. I made observations at Ooldea Bore, and through the kindness of Mr. T. R. Nealyon I was enabled to travel by motor-lorry out on to the Nullarbor Plains, and to make 2 more stations.

The Nullarbor Plains carried practically no feed whatever, and the next water on the surveyed line from Ooldea Water was at Bore 4 in Western Australia, a distance of 210 miles. I decided, under these circumstances, to travel southward and strike the overland telegraph line at White Well, in order to give the camels water. White Well is distant from Ooldea Water 109 miles. The camels refused the water at Bore A (26 miles west of Ooldea), as it was too salty. By good chance, a sharp shower put 150 gallons of water in Nealyon's Rock-Hole, thus shortening the 109-mile dry stage to 75.

At Nealyon's Rock-Hole I met Mr. Grill, Commonwealth Inspector of Bores, who gave me every possible advice regarding water along the railway survey line in Western Australia. On arriving at White Well October 2, 1914, I telegraphed Mr. Kidson, and then hastened with all possible speed to Eucla, and arrived there October 10, having traveled along the telegraph line from White Well, a distance of 130 miles in 8 days, and having made 3 sets of observations.

At Eucla I wired to Mr. Kidson that I intended pushing on to No. 4 Bore, a dry stage of 78 miles, and so return to the railway survey line. My plans were to pick out 4 of the best camels and travel to No. 4 Bore, water the camels, and then journey 36 miles east to the border of South Australia and Western Australia, and make a station. Then we were to travel west again, obtaining water at a few places of which Mr. Grill had told us. Having a practical engineer in the party, we would have been enabled to obtain our next water at a bore 83 miles west of No. 4, where there were a steam engine and pump but no one there to work it. However, having received a telegram from Mr. Kidson on October 10 to abandon the journey, I sent all the camels back to Hergott Springs. They left Eucla on October 13.

I made a repeat station at Eucla, and carried on computations until November 8, when I embarked on the steamer *Eucla,* which calls at Eucla once in 3 months, and reported to Mr. Kidson on November 15, 1914, at Cottesloe, Western Australia.

The stations occupied are given in the following table:

TABLE 23.

No.	Name	Date	Lat. South		Long. East	
		1914	°	′	°	′
1	Port Augusta	Aug. 6-7	32	29.7	137	46
2	Bookooloo	" 23	31	54.2	137	22
3	East-West Railway Siding	" 27-28	31	16	136	47
4	Wirraminna	Sep. 1	31	10.9	136	16
5	McArthur's Well	" 3	31	01.4	135	43
6	Gilbert's Well	" 5-6	30	51.4	135	06
7	Tarcoola	" 8	30	41.8	134	34
8	Carnding Well	" 12-13	30	27.4	134	13
9	Wynbring Rock-Hole	" 16	30	33.7	133	39
10	Bench-Mark 56½	" 19	30	32.8	132	46
11	Ooldea Bore	" 23-24	30	27.9	131	50
12	Bore, *A*	" 25	30	30.2	131	25
13	Bore, *B*	" 26	30	34.1	130	55
14	Nealyon's Rock-Hole	Oct. 1	31	07.0	131	17
15	Mallabie Tanks	" 4-5	31	27.8	130	39
16	Yangoonabie	" 6	31	28.5	130	05
17	Bunabie	" 8-9	31	31.2	129	22
18	*Eucla*	" 31	31	43.3	128	53

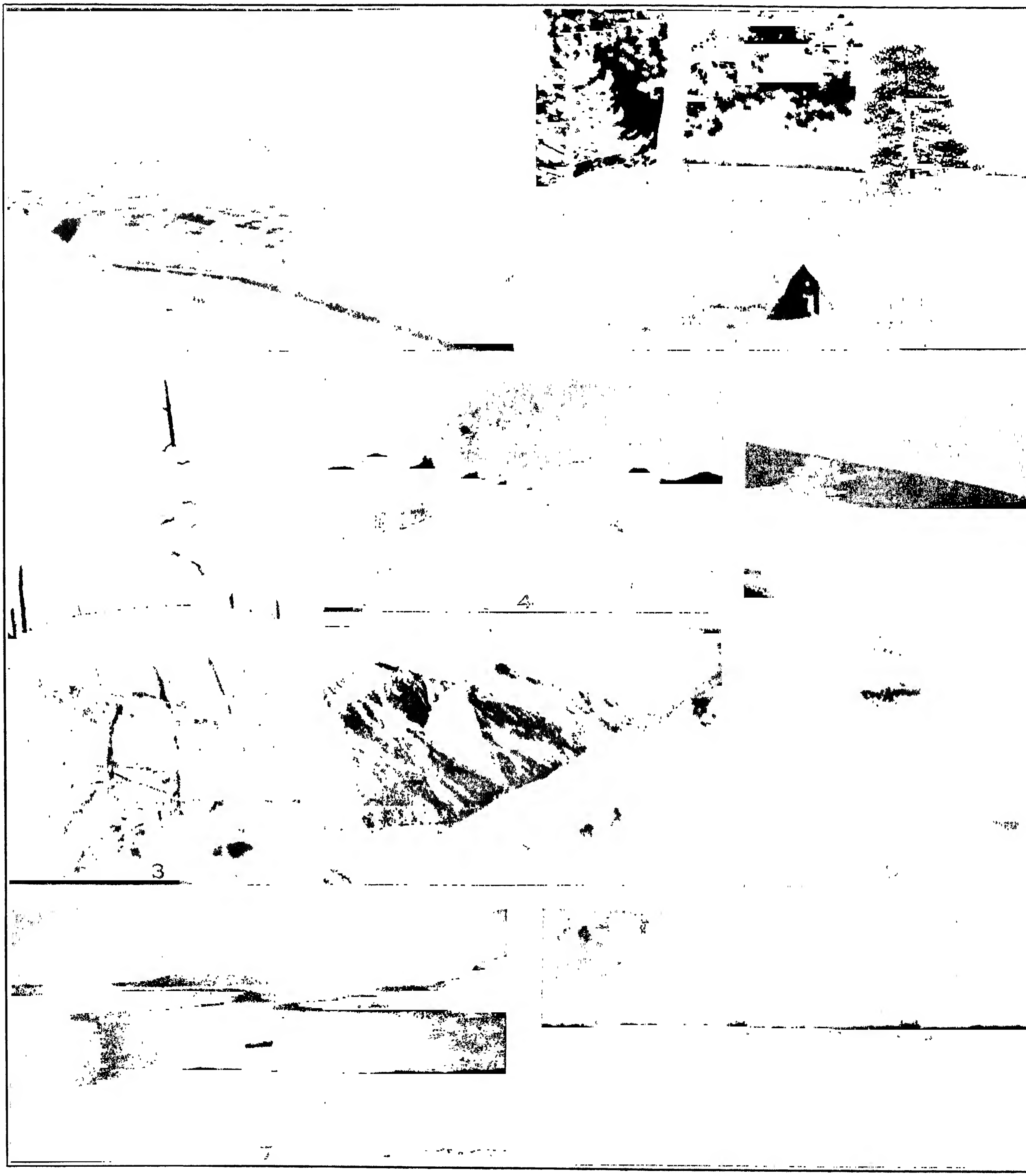
I left Port Augusta August 19 and arrived at Eucla October 10, a total of 52 days field traveling, making an average field time of about 3 days per station. The total distance traveled in the field was 814 miles, which gives an average of 45 miles approximately per station. The average field expense per station was $113.50.

The country is magnetically disturbed between Gilbert's Well and Ooldea. The geological formation is pleistocene and pliocene sands, limestone, etc., overlying granites and gneisses, which outcrop in various places. Mount Christie, about 20 miles northwest of Wynbring Rock-Hole, is known as a magnetic hill. Between Ooldea and Eucla there is less disturbance, the country being mainly the miocene and eocene limestones of the Nullarbor Plain.

Assistance in many ways that promoted the success of the expedition was extended by various officials and men of the country. The Engineer-in-Chief of South Australia kindly gave permission to hire camels from Hergott Springs, and Mr. J. G. MacDonald, in charge of the depot, supervised the selection. Chief Inspector Clode of Port Augusta gave me valuable advice regarding the character of the proposed route. The mess of the telegraph station at Eucla very kindly placed a room at my disposal during my enforced stay. Mr. T. R. Nealyon of Fowler's Bay enabled me to make stations west of Ooldea by giving the use of his motor-lorry for two days. Mr. F. M. Best, mechanical and electrical engineer, accompanied me on the caravan trip and rendered valuable aid in handling and managing camels, besides recording my astronomical observations.

E. KIDSON, ON THE GENERAL MAGNETIC SURVEY OF AUSTRALIA, AND ON AN EXPEDITION OVER THE CANNING STOCK-ROUTE, WESTERN AUSTRALIA, 1914.

This work is a continuation of the general magnetic survey of Australia, the plan of which was outlined in the Director's instructions of June 21, 1911. The progress of the survey to the close of 1913 is described in the Department's "Land Magnetic Observations," Volume II. During January 1914 I used universal magnetometer No. 14, and from April to October, magnetometer-inductor No. 24, with chronometers, watches, and accessories.



TYPICAL VIEWS OF MAGNETIC EXPEDITIONS IN NORTH AND SOUTH AMERICA.

1. San Mateo, Peru.
3. Trachyte Mt., Colorado, United States.
7. Ashe Inlet, Northwestern Territories, Canada.
4. Quixada, Brazil, showing huge outcroppings of granite.
5. Andes near Puente del Inca, Argentina.
2. Woodland Park, Colorado, United States.
6. Chupaca River, Peru.
8. Bocas del Toro, Panama.

At the beginning of the year I was engaged on magnetic work in Tasmania. Mr. F. Brown, who had just completed his campaign in Cape York Peninsula, reported at Hobart on January 6, and between us 13 stations in all were occupied in Tasmania, King Island, and Flinders Island. Six of these 13 were reoccupations of stations established by McAulay and Hogg in the magnetic survey of Tasmania, another was a reoccupation of the site of Kays Observatory at Hobart, the magnetic field of which is now slightly disturbed by the proximity of buildings. Observations were made at 3 widely separated stations located within the region about Southport, which was found by McAulay and Hogg to be so greatly disturbed magnetically. The disturbance occurs near the junction of a sandstone formation with a relatively highly magnetic diabase, the prevailing rock in the district, and appears to decrease on proceeding from this junction further on to the diabase. After completing the work in Tasmania, Mr. Brown and I were on leave of absence to February 28, when duties were resumed at Melbourne.

Mr. W. C. Parkinson, detailed to the Australian work, having arrived from Washington, the whole party proceeded March 5 to Adelaide, and received the remainder of the outfit returned by the Australasian Antarctic Expedition. Magnetometer No. 9 of this outfit was compared with magnetometer-inductor No. 24 and universal magnetometer No. 14 at Blackwood, near Adelaide. A reoccupation was made of our 1911 station at South Park, Adelaide. At the close of the intercomparisons, Mr. Brown was detailed to work in the Northern Territory, and accordingly left Adelaide March 16 (see Mr. Brown's report), and Mr. A. L. Kennedy of Adelaide, recently magnetic observer at the second base of the Australasian Antarctic Expedition, was assigned to the party.

During the latter end of March our 1911 stations at Murray Bridge, Port Victor, and Border Town were reoccupied, and a new station was established at Beachport by Messrs. Parkinson, Kennedy, and myself. Messrs. Parkinson and Kennedy received practical instruction in field work on this trip preparatory to undertaking their respective expeditions. Mr. Parkinson left Adelaide March 28, and made preparations at Perth for his campaign in the interior of Western Australia (see Mr. Parkinson's report).

Before leaving Adelaide for Perth on April 3, I gave Mr. Kennedy instruction in general duties, and superintended preparations for his journey from Adelaide to Farina (South Australia), Birdsville (Queensland), and back via Hergott Springs to Adelaide. This expedition was completed July 7, when Mr. Kennedy returned to Adelaide. His next expedition was to have been by camel from Port Augusta to Kalgoorlie along the proposed route of the transcontinental railway, and the journey was actually commenced in the latter part of August. Unfortunately, however, a very severe drought was experienced over the greater part of Australia during 1914, so that Mr. Kennedy was compelled by scarcity of feed and lack of water along the transcontinental route to make for the coast at White Well and thence to follow it to Eucla. From Eucla he had intended to go northward again and follow the railway route to Kalgoorlie. As feed was likely to be very scarce and the supply of water was at best problematical, I considered it unsafe for the party to proceed, and Mr. Kennedy was instructed to abandon the trip, return his camels to their base at Hergott Springs by the best route available, and report as soon as possible to me at Perth. After a long wait at Eucla, he took passage by the quarterly steamer, and arrived at Perth November 15. Mr. Kennedy's expeditions are described in his reports.

Having left Adelaide April 3, I arrived at Perth on April 7. While planning Mr. Parkinson's work, I made preparations at Perth for a journey across the interior of Western Australia from Wiluna to Hall's Creek by the Canning Stock-Route and thence to Wyndham. The necessary camels for this trip were hired from the Water Supply Department of Western Australia. These camels being at Kalgoorlie, the start had to

be made from that place. Leaving Kalgoorlie May 12, they were marched quickly to Leonora, the terminus of the goldfield's railway, whither I repaired by train from Perth with the greater part of the outfit. During preparations for the journey, opportunity had been taken to reoccupy our stations at King's Park, Perth, and Coolgardie.

The whole party, consisting, besides myself, of 3 white men, Messrs. Clarke, Cronin, and Ryan, and an aboriginal called "Nipper," together with the 12 camels and all stores, instruments, and gear, were assembled at Leonora on May 18. Two of the white men acted as camel men, and the third as cook. Nipper, who had previously traversed the stock-route three times with Mr. Canning while it was being opened up, was especially useful in following the faint pad left by Mr. Canning's camels and for his knowledge of the nature of the track, distances between waters, the quality of the latter, and the exact location of feed for the camels. The stores and other gear to be carried by the camels are packed in pairs of boxes, leather pack bags, or iron tanks, one pair going to each camel (see view 1 of Plate 4). It is essential that the members of each of the pairs should be of the same weight, so that the loads will balance well. Our impedimenta were arranged with this object in view, one pair of boxes being reserved for my instruments and personal gear, while the water tanks made another load. Three light camels were used for riding. A set of magnetic observations having been completed, and, all being in readiness, we left Leonora on May 19 for Lawlers.

The daily routine was as follows: the cook gets up at the break of dawn. Half an hour later, every man has rolled his "swag" (blankets, etc.) and is ready for breakfast. After this meal, the camel men go out for the camels, which are usually followed by tracking, in aboriginal style, till they are seen or their bells heard. Having caught and unhobbled them, the men string them together and make for camp by the most direct route, which an experienced bushman is able to find, when to the ordinary individual there seems to be not a single landmark. Arriving at camp, by dint of hissing or calling "Hooshta," each camel is made to kneel down between the two packages which form the evenly balanced halves of his load. In the meantime, the cook, Nipper, and I have completed the packing for the day. All hands now proceed to put the saddles on the camels' backs and then load up. The two halves of the load are lifted, one on to each side of the saddle, and are then tied together across it, balancing on the saddle in such a way as to pinch the camel as little as possible and to prevent the rocking of the load and consequent chafing of the camel's back. Saddles and small articles of personal gear, and lunches of rough sandwiches are put on the riding camels. When all are ready, they are made to rise and are tied together in a string by light ropes with thinner twine at each end. These "noselines," as they are called, pass from the wooden peg in the nose of one camel to the tail of the one in front of him. In an emergency, the twine can be snapped without hurting the camel's nose. The leading camel is now led or ridden at a uniform pace of 2½ miles per hour which is maintained, bar stoppages to adjust loads, till camp is reached in the evening. Immediately camp is reached, the camels are compelled to kneel again, and the loads are lowered to the ground.

On arriving at a magnetic station, I proceeded at once to put up the tent, with Nipper's help, to set up the instrument, and to secure as many observations as possible before dark. The camels were allowed to cool off for about half an hour before their saddles were removed, and with their fore feet close hobbled, they were turned out for the night to feed. As night fell, we were usually having supper, after which observations and computations were continued till 9:30 or 10:00 p.m., when I turned in on my folding cot. After leaving Lawlers, observations were secured at alternate camps and computations completed between times. On Sundays a needed rest was given the camels, and the opportunity was taken to wash clothes and make short hunting expeditions. The distance traveled each day was fixed by the wells and waters and patches

of feed. The usual time of starting was about 9 o'clock and of camping about 3 o'clock, the day's journey averaging 16 miles on fair roads, but sometimes not more than 12 miles in sand-hill country, where the going was heavy.

From Leonora to Lawlers (85 miles) and Wiluna (220 miles) the country is typical of the Western Australian gold-fields. It consists in general of flat country with low ridges here and there, which often rise very abruptly and are termed breakaways. On these ridges the surface is rubbly or rocky, while on the flats it is composed of a red sandy loam which produces a fine dust, very difficult to remove. The underlying rocks are, as a rule, granitic or dioritic, the former being intrusive in the latter. A great part is covered by "mulga scrub," an acacia about 10 to 20 feet high, with succulent needle-like leaves, which is good feed for camels and is also eaten by sheep and cattle. Between the mulga bushes grow salt-bush (extremely important as feed), various herbs, and, after rain, grasses. A great part of the surface is, however, usually bare. The mulga is sometimes replaced by other varieties of scrub, and along the occasional creek beds, which are dry except after rains, various kinds of eucalyptus grow. In this particular season, after several dry years, the mulga and salt-bush were in a very bad state. In fact, so much was killed that the camels fared poorly. Grass was also very poor and scarce.

The towns are very small mining towns with hotels, stores, a bank, mining registrar, blacksmith, saddler, post-office, etc. Lawlers was reached May 25, and Wiluna June 2. At Wiluna the final supply of provisions was taken on, and civilization was left on June 5. From here on spinifex, a coarse, hummocky, spiky grass, became much more plentiful. This spinifex grows in the worst country in Australia, particularly where there is moving sand. It is useless as feed.

All along the stock route between Wiluna and Halls Creek, wells or natural waters occur at an average distance of about 15 miles. The wells were sunk to supply traveling cattle for which the route was opened up. For various reasons, however, only two attempts to traverse the track with herds of cattle were made, so that it had been abandoned for nearly three years before our own crossing. The wells and waters are numbered in order from south to north. Before leaving Wiluna we were urgently advised by all to take no risks whatever with the Blackfellows, who were regarded as teacherous and unreliable.

From Wiluna to No. 11 Well at Goodwin Soak, the surface of the country is of red soil similar to that of the gold fields. The supply of feed was fair to No. 3 Well, as there had been recent rains, and a considerable number of kangaroos, wild turkeys, galahs (red and slate-colored cockatoos), and other birds were seen, also the tracks of a number of dingoes.

No. 4 Well is at the foot of a fairly high range of hills near the shore of Lake Naberu, a typical lake of the interior of Western Australia. These lakes of the interior are dry, except after heavy rains, and their beds are covered with deposits of salts. As there is water usually but a short distance below the bed, very good bush and herbage are often found on the shores and sometimes even on the lake-bed. This season, however, the lake was quite dry and vegetation parched. Cattle were on the south side of the lake where a shower had filled some water-holes and some grass had grown.

On the north side of the Naberu system is Windich Spring No. 4A Water, where there is a permanent pool. It was here that we saw the last cattle. Dingoes were plentiful around our camp at this water.

Passing down the creek-bed leading from Windich Spring, we came upon several water-holes and startled a number of turkeys, water-hens, ducks, and galahs. Some of the ducks and galahs were shot for food. Leaving the creek, the road led to No. 5 Well through flat, clay-pan country with mulga, salt-bush, and herbage, which, however, were all very dry.

Between No. 5 Well and No. 6 Well the country was mostly barren, parched, spinifex country with occasional patches of good quondong (a native edible bush which bears a fruit). No. 6 Well, at Pierre Spring, is in a patch of travertine limestone, deposited by the spring, on which salt-bush, acacia, and other good feed grows, forming quite an oasis. On June 16, between No. 6 Well and No. 7 Well, two emus were seen, also the fresh tracks of two Blackfellows. Between No. 7 Well and No. 8 Well, on June 17, on a rich limestone flat with mulga, salt-bush, and grass, we found a number of very large kangaroos. These were the last seen until the northern end of the stock route was reached. Presumably, there is not sufficient feed in the large area between to support them continuously. On June 18 Weld Spring, No. 9 Well on the stock route, was reached. This is in a basin in the hills and has been visited by a number of Australian explorers who have always found plenty of good water and feed. We were greatly surprised to find the well dry and indeed very little feed about.

At No. 10 Well, June 19, for the first time, we came across a band of natives, whose tracks we had seen for several days past, getting fresher and fresher. We saw two old men, a youth, a boy, four old women, and one young woman. As usual, there was a plentiful supply of dogs. Although they knew a few words of English, they were very unintelligent, and we found it almost impossible to communicate with them. When we broke camp the next morning, we soon found that the blacks were following us, which made our riding camels very nervous. After a good deal of persuasion, they realized that we wanted them all to "Walkaway!" and they soon disappeared.

On June 20 we reached No. 11 Well at the Goodwin Soak, on the edge of another lake system. Here the dray track we had hitherto followed ends, and the character of the country changes to moving sand-hills. Spinifex is more universal, while the mulga becomes scarce. From now on we had to follow the pad left by the camels of Mr. Canning's expedition.

Traveling over the broken sand-hills is very heavy and exhausting work for the camels, and their backs require great attention. Between No. 11 Well and No. 17 Water the sand-hills were varied by flats with oak, mulga, wattles, salt-bush, quondong, poplar, and gums sparsely scattered among the spinifex. There were also a few clay-pans, or flat spaces covered with a fine clay that holds water for a considerable time after rain, and which are typical of sand-hill country. The water in the wells was exceptionally low and consequently tasted unusually strong of minerals. That at No. 16 Well was not potable. Numerous traces of blacks were seen, and at one well it was evident from the tracks that a native had been surprised by our approach, and after first crawling had then run away.

No. 17 Water, Killagurra Spring, is in a narrow, precipitous gorge in the Durba Range, which reaches a height of about 1,000 feet above the surrounding plain. The range rises precipitously and is capped by a hard, thick stratum of quartzite. This spot proved the most interesting on the whole trip. The cliffs abounded in wallabies, which came out at dawn and dusk to feed. On some overhanging rocks in the gorge we found a large number of aboriginal rock paintings, done in yellow ochre, picked out with red. There were some very fine white and blood-wood gum trees in the lower portion of the gorge, and in the upper portions were some unique instances of erosion by flood waters. Sunday, June 28, was spent at this camp.

Leaving No. 17 Water, we again got among steep broken sand-hills, in which the pad made by Mr. Canning's camels was difficult to find. The aboriginal, Nipper, was more expert at finding it than we were, and he doubtless saved us many hours. Wells Nos. 19 to 22 were all near the shore of a large dry lake, "Lake Disappointment." The water in some of these wells is very strongly impregnated with mineral salts, though stock will drink it. There was still fair feed near the lake shore, although the season was dry. Red oaks were abundant in this region, and very handsome. All

through the sand-hill country, spinifex rats (a variety of kangaroo-rat) and bandicoots were common. On the lake shore they often made their homes in deserted ant-hills.

North of Lake Disappointment, No. 21 Well to No. 24 Well, there had been recent rains, bringing up fresh herbage on which the camels fed well. This was fortunate, as otherwise there was little else but spinifex. Tracks of natives were seen, and at No. 22 Well our camp was visited at night by their dogs. Between No. 22 Well and No. 25 Well the typical breakaways again were common and quartz reefs were seen. The country is said to be auriferous. Sunday, July 5, was spent at Karara Soaks, No. 24 Well, where the feed was very good. At this place there were numerous worn stones used by the natives in grinding grass and wattle seed. The sand-hills on the north side of Lake Disappointment were remarkably long, high, and parallel, and the sweep of the surface between them made a remarkably regular curve.

At No. 27 Well we surprised a native woman, who immediately fled. Tracks of others were visible over all the country. At No. 28 Well we again surprised a party of blacks, two gins (women) and two piccaninnies, who also fled, leaving behind all their goods, including a large number of recently caught bandicoots. Next morning, however, as we left camp, three men and a boy appeared. They had left their spears behind, and to show their innocent intentions, called out "Poorfellow," "Nothing sulky fellow." Nipper went over and held limited converse with them and distributed some tobacco among them. They appeared much more intelligent than the first band, seen at No. 10 Well. After a while, they disappeared, but were soon seen again following us with the gins we had seen the previous day and hunting as they came along. At night, they camped near us at No. 29 Well. The following day I warned them not to follow us. It is not safe to let them learn one's habits.

Nos. 30 and 31 Wells were on a limestone flat where the feed and the going were both good. At No. 33 Well there were traces of a large camp of blacks where a "corroboree," as their meetings for tribal ceremonies are called, had evidently been held. From here on, tracks were seen every day, and there were old camps at nearly all the wells. Sand-hills and spinifex were again predominant from No. 32 Well to No. 37 Well, with frequent groves of oaks and occasional clay-pans between the sand-hills.

Our approach was everywhere heralded by fires, which were probably warning signals made by the natives to one another. At No. 37 Well is the grave of Messrs. Thompson and Shoesmith, the first men to attempt to traverse the route with cattle. They and one of their black boys were killed while asleep, and found later by Mr. Cole, who was following with another herd of cattle. Sunday, July 19, was spent at Wardabunna Rock-Hole, No. 38 Water, in a small gorge, on a low rubbly range. Natives were camped quite close, their dogs being continually around our camp, so that special precautions were taken.

From No. 38 Well to No. 40 Well difficult sand-hills again alternated with lake surface and clay-pans. The track was scarcely discernible. At No. 40 Well is the grave of M. Tobin, who, while on Mr. Canning's expedition, was speared by a native. A "corroboree" had been held recently at No. 41 Well, where we saw the first evidence of wanton damaging of a well by natives.

The sand-hill country continued to the region of the Sturt Creek at No. 51 Well. Between No. 43 Well and No. 46 Well, however, we encountered the worst part of the trip, and for two nights the camels had to be tied down without feed, to prevent their wandering uselessly. On a lake beyond No. 45 Well, good feed was again found, however, and thereafter it was always fair. Flocks of galahs and gray pigeons were seen at most of the wells, and they were often used to vary our menu. At No. 45 Well more natives were seen, who were acquainted to some extent with the white man. I forbade them, however, to follow us far, though they appeared quite friendly.

Saturday, August 1, was spent at No. 48 Well, where the feed was good, and in the afternoon we explored the large breakaway of the South Esk Table-land. View 5 of Plate 4 is typical of the country here. When approaching No. 49 Well, another party of natives was seen to run away on our approach, leaving a meal of white ants.

On August 4, about 3 miles beyond No. 51 Well, we camped on a small lake, being the first of the country flooded by the Sturt Creek. The latter is an inland river flowing in the wet season only and emptying into the Gregory Salt Sea. Here feed was most abundant, there having been good rains recently. Emus, native companions, and ducks were plentiful. The lake surface was covered with luxuriant herbage about 1 foot high and forming the richest fodder. From here to Flora Valley station, our track lay along the Sturt Creek. Water was obtained from natural water-holes along the creek-bed. Some of these were very long, the two longest being about 3 and 4 miles long, respectively. Game and fish were abundant. Between the sand-hills and the creek on either side is a flooded area which affords good grazing for cattle. In about latitude 19° 15′ south, we saw the first cattle of the Sturt Creek station. As there had been insufficient rains here, the grass on the river flats was cut close and from here to Flora Valley camel feed became scarce. Kangaroos were again seen along Sturt Creek. On the evening of August 13 a stockman belonging to Sturt Creek station, the first white man we had seen since leaving Wiluna, came into our camp and gave us a very succinct account of the world's news up to July 31.

On August 16, at Flora Valley, we received a hearty welcome from Messrs. Gordon Brothers and Buchanan. The feed at Flora Valley was fair, while at Hall's Creek not only was it poor, but there were also poisonous bushes. I, therefore, decided to retain most of the camels and gear at the former place, and to give the camels the necessary rest before turning back.

On August 17 and 18, Mr. Ryan and Mr. Buchanan rode by horse to Hall's Creek to send telegrams and to get mail, while I made my observations. Three days later I followed with Clarke, Cronin, and 4 of the best camels. After the necessary stores for the return journey were procured, August 22, Clarke and Cronin left Hall's Creek for Flora Valley, and remained a week on the small lake at Sturt Creek, where the feed was very good, putting the camels in good condition for the bad stretch beyond No. 45 Well. They reached Wiluna November 9, after a good trip, finding feed more abundant on the way back as the result of recent rains. Leonora was reached November 23, and the camels were returned to the Water Supply Department the following day.

Meanwhile, at Hall's Creek I was made welcome by the postmaster, Mr. F. W. Tuckett, and his wife, who entertained me at their own house. As Messrs. Gordon Brothers and Buchanan were traveling to Wyndham, I purchased a buggy and horse and arranged to travel with them. We left Hall's Creek on August 29. On the way to Wyndham we stayed for two days at Moola Bulla, the government aboriginal station, where we were hospitably entertained by Mr. and Mrs. Haly. Passing through Turkey Creek telegraph station, we reached Wyndham on September 21, where I took passage on the steamer *Kwinana* for Perth, arriving October 2. Between Leonora and Hall's Creek 39 magnetic stations were occupied, and between Hall's Creek and Wyndham, 8.

Table 24 shows the stations at which magnetic observations were made and the order of occupation; for values of the magnetic elements, see Table of Results.

All the field parties met at Perth, where an intercomparison of all the instruments used during the year was made and the checking of computations proceeded with, while the observers awaited assignment to other fields of work.

On November 28, in company with Mr. Kennedy, I left Perth for Adelaide. Mr. Kennedy completed his duties by closing up the affairs of his expedition to Eucla after

TABLE 24.

No.	Name[1]	Date	Lat. South		Long. East	
		1914	°	′	°	′
1	Southport, *A*, *B*	Jan. 2–3	43	25.9	147	01
2	Southport, *C*	" 4	43	26.2	147	00
3	Hobart, *D*	" 7	42	52.2	147	21
4	Oatlands	" 9	42	17.2	147	23
5	Scamander, *A*, *B*	" 12	41	26.7	148	18
6	Latrobe	" 14–15	41	14.8	146	27
7	Currie, *A*	" 18	39	56.0	143	50
8	Currie, *B*	" 20	39	54.3	143	51
9	Melbourne	Mar. 2–3	37	49.9	144	58
10	Blackwood, *A*, *B*, *C*	" 10–14	35	00.6	138	36
11	Port Victor	" 17–18	35	31.8	138	37
12	Murray Bridge	" 20	35	07.2	139	16
13	Border Town	" 21	36	18.5	140	46
14	Beachport	" 23–24	37	28.8	140	00
15	Coolgardie	May 9	30	57.2	121	11
16	Leonora	" 19–20	28	52.0	121	18
17	Lawlers	" 25	28	05.2	120	30
18	Lake Miranda	" 27	27	43.2	120	33
19	Logan Well	" 29–30	27	15.7	120	28
20	Abercromby Well	" 31– June 1	26	51.6	120	20
21	Wiluna	" 3	26	34.7	120	14
22	Kookabubba Well	" 6	26	21.2	120	18
23	Water No. 2A	" 8	26	00.9	120	20
24	Well No. 4	" 11	25	37.2	120	33
25	Well No. 5	" 14–15	25	22.8	121	01
26	Well No. 7	" 16–17	25	09.7	121	17
27	Weld Spring	" 18–19	25	01.2	121	33
28	Goodwin Soak	" 20–21	24	44.6	121	43
29	Well No. 13	" 23–24	24	25.5	121	57
30	Well No. 15	" 25–26	24	08.4	122	10
31	Water No. 17	" 27–28	23	43.5	122	27
32	Well No. 19	" 30– July 1	23	25.2	122	28
33	Well No. 21	" 2–3	23	10.8	122	44
34	Karara Soaks	" 4	23	06.8	123	18
35	Well No. 27	" 7–8	22	47.8	123	34
36	Well No. 29	" 9	22	33.4	123	48
37	Well No. 31	" 11–12	22	31.7	124	21
38	Spinifex Camp	" 14	22	18.2	124	47
39	Wanda	" 16–17	22	08.4	125	15
40	Wardabunna	" 18–19	21	57.8	125	31
41	Wadawalla	" 21	21	40.3	125	47
42	Guli	" 23–24	21	19.5	125	53
43	Billowaggi	" 24–25	21	13.8	125	59
44	Pijallinga Claypan	" 27	20	54.5	126	10
45	Kuduarra	" 29	20	38.4	126	20
46	Well No. 48	" 31– Aug. 1	20	15.2	126	35
47	Well No. 50	" 3	20	12.8	127	01
48	Lungan Pool	" 5	20	01.4	127	26
49	Cutharra Pools	" 7	19	43.5	127	34
50	Wolf Creek	" 10	19	22.3	127	48
51	Sturt Creek	" 12–13	19	08.2	128	13
52	Cow Creek	" 14–15	18	38.5	128	22
53	Flora Valley	" 18	18	16.0	127	59
54	Hall's Creek	" 25	18	15.3	127	46
55	Moola Bulla	Sept. 2	18	11.8	127	28
56	Rosie's Creek	" 5	17	47.3	127	48
57	Fourteen-Mile Creek	" 7	17	44.8	127	52
58	Turkey Creek	" 11	17	01.9	128	13
59	Bow Creek	" 13	16	39.8	128	12
60	Wild Dog Spring	" 15	16	14.1	128	21
61	Cheese Tin	" 17	15	49.8	128	20
62	Six-Mile Hotel	" 20–21	15	29.8	128	08
63	Cottesloe	Nov. 17– Dec. 7	31	59.3	115	44

[1] Stations Nos. 1 to 8 are in Tasmania; No. 9 is in Victoria; Nos. 10 to 14 are in South Australia; and Nos. 15 to 63 are in Western Australia.

our arrival at Adelaide December 2. I proceeded to Melbourne, where matters in connection with the work in Australia were wound up. The return journey to Washington began December 9. The route taken was from Melbourne to Syndey, Wellington (New Zealand), Rarotonga, Papeete, and San Francisco, and thence by rail to Washington. The journey was broken at Wellington so as to enable me to spend 3 weeks in New Zealand on leave. I secured passage on the steamer *Marama* January 7 at Wellington, and reached San Francisco January 27. Taking train for Washington the same day, I arrived January 31, and reported at the office on the following day.

Messrs. Brown and Parkinson were engaged in completing the intercomparison work and in the checking of computations until their assignments, on December 10 and December 26, respectively, to new field campaigns.

Australia, as a whole, is highly disturbed magnetically, but particularly in Tasmania, South Australia, Victoria, and the coastal districts of New South Wales. The great central and western desert and semi-desert country is probably somewhat less disturbed than the coastal areas. There are numerous cases of very marked local disturbance in Tasmania and on the mainland, *e. g.*, Port Walcott, Mount Magnet, and Magnetic Island. These are usually traceable to geological formations, but in South Australia this is not so obviously the case.

Throughout the whole work in Australia, great assistance and encouragement were received from many government officials in all parts of the Commonwealth. This was especially true with regard to the various lands and survey departments, and the government observatories. In the more sparsely populated districts, members of the party were often dependent on the hospitality of the settlers, which was always of a most cordial description.

We are especially indebted to the kindness of Mr. P. Baracchi, the Government Astronomer of Victoria, and of his chief assistant, Dr. J. M. Baldwin. Mr. Baracchi's interest enabled me to use the Melbourne Observatory as a base-station to which my mail could be addressed, and at which, with his assistance, intercomparisons of instruments could be made. He also loaned a dip circle on several occasions, and helped in numerous other ways.

W. C. PARKINSON, ON MAGNETIC WORK IN WESTERN AUSTRALIA, APRIL TO OCTOBER 1914.

Following the instructions of my chief of party, Mr. E. Kidson, dated April 22, 1914, I proceeded to carry out a survey along the southwestern and southern coasts of the state of Western Australia, and along the rabbit fence running northward across the state to Port Hedland. The instrument used for this work was universal magnetometer No. 14 with the usual accessories. As the work outlined lay across regions where there were but few railways, it had been planned to use a small automobile for transportation, and accordingly one was purchased for the purpose. Mr. W. B. Alexander of the Western Australia Museum accompanied the expedition over the first portion of the journey, in order to collect natural history specimens in a region which had been little visited for that purpose.

We left Perth April 24, going first south by way of Bunbury and Cape Leeuwin, and thence to Albany. After a short trip to Port Frankland, and a further delay on account of heavy rains, we left Albany for the east on May 12, intending to follow the coast to Bremer Bay. Owing to a breakdown resulting from becoming mired in a bog, it was not until May 15 that we arrived at Marra on the Pallinup River. Here we learned that the road to Bremer Bay was impassable, and a detour was made by way of Ravensthorpe in order to reach Hopetoun. We then followed the rabbit fence northward to 129-Mile Hut (see view 4 of Plate 4) where a station was established, after which we went eastward again, reaching Esperance on May 26. Traveling eastward from the

rabbit fence was very slow on account of numerous creeks and swamps, as well as patches of sand and scattered tree stumps. So rough was the going that on one occasion a whole day was consumed in going 28 miles.

It was found at Esperance that further progress along the coast was quite impossible with the car, and so by the kind assistance of the Surveyor-General arrangements were made with the State Steamship Company that the steamship *Eucla* should remain at Israelite Bay long enough to permit me to make a series of magnetic observations. Unfortunately the day was overcast so that determination of declination was impossible.

In order to use the car from Esperance to Eucla, it was necessary first to go northward to Norseman, and thence eastward by way of Balladonia. After provisioning at Norseman for the long overland journey, we started on June 3. For the first 130 miles the track was generally fair, though there were some sandy patches. The most serious trouble was caused by tree stumps which occurred frequently along the cleared track through the bush, and were often quite hidden by clumps of salt bush. Our front axle was badly bent by one just before reaching Fraser's Range on the first day. Fortunately repairs could be made at the station, and we proceeded the following day to Balladonia. An effort was made here to secure camels to make the trip into Eyre along the coast, as this road is impassable except by camels. In this I was unsuccessful and decided to proceed in the car by a more northerly route to Eucla, where I arrived on June 10. Observations here were delayed by several days of severe sandstorm, and it was June 15 when we were ready to begin the return journey.

After a succession of accidents to the car it was decided, when about 60 miles north of Norseman, to send the car to Perth by rail where it could best be put in order for succeeding work. We accordingly terminated this portion of our work at Perth June 30.

On July 31, I again left Perth in the motor-car and proceeded eastward to the rabbit fence by way of York and Merredin, to 21-Mile Hut, where observations were made on August 2. The rabbit fence was followed northward as far as the gate opening westward to Cue, where we directed our course to Meekatharra and Nannine, and thence our progress was along the Nullagine Stock-Route to Nullagine and Marble Bar. This trip was made without incident more serious than becoming fast in a salt marsh near Nannine, when we had to walk 6 miles to secure a man and team of horses to pull the car out to hard ground. Along the stock-route the track is in general moderately good though cut up in places by the cattle. Crossing several creeks was the most serious difficulty and required strenuous exertions in which we were assisted in some cases by the natives. The road from Nullagine to Marble Bar is extremely hilly, but the surface is generally good, and the creeks have been spinifexed for the motor-lorry which runs once a week. The road from Marble Bar to Port Hedland is considered passable for the first 80 miles; after that and until Port Hedland is reached there is very heavy sand. Only one car has been known to have made this run, and then only by the illegal proceeding of traveling on the railway track over the sandy stretches. It was therefore imperative at this stage to send the car by rail to Port Hedland, from which point it was shipped in charge of the driver to Perth.

Having disposed of the motor-car, I made a short trip by sailboat to Ballaballa, and later by steamer to Broome and Derby. The Mission lugger *W. S. Park* picked me up at Derby, and carried me to Port George IV, and returning by way of Montgomery Islands, and Sunday Island in the Buccaneer Archipelago, enabled me to make magnetic observations at those places. On my arrival at Broome I took the first southbound steamer and arrived at Cottesloe on October 23.

The distance between stations on this work is considerably greater than has been the custom when travel has been by caravan, and the cost per station has been higher than would have resulted from a more compact distribution. Many of the tracks had

never been traversed by a motor-car before, and were not suited to that form of transport. The consequent wear on machinery and tires was excessive. The loss in disposing of the car was greater than had been estimated on account of the depression produced by the European war. The field-expense per station for the 36 stations was a little less than $50; the total distance traveled, including going to and returning from the field, was about 7,500 miles, of which more than 4,000 was by motor-car.

Table 25 shows the stations at which magnetic observations were made, with date of occupation, and geographic position; for values of the magnetic elements, see Table of Results.

TABLE 25.

No.	Name	Date	Lat. South		Long. East	
		1914	°	′	°	′
1	King's Park, Perth	Apr. 6, 8, " 13	31	58.0	115	50
2	Rottnest Island	" 14	32	00.2	115	33
3	Bunbury	" 25–26	33	19.5	115	38
4	Cape Leeuwin	" 28	34	22.1	115	08
5	Port Frankland	May 5–7	34	59.8	116	49
6	Albany	" 9	35	01.3	117	55
7	Marra	" 16	34	25.4	118	47
8	Hopetoun	" 19	33	53.6	120	09
9	Rabbit-Proof Fence 1	" 21–22	32	54.0	119	48
10	Esperance	" 27	33	51.4	121	53
11	Israelite Bay	" 30	33	36.4	123	48
12	Balladonia	June 6, 20	32	28.4	123	53
13	Cardanumbi	" 8	32	16.3	125	38
14	Eucla	" 12–14	31	43.3	128	53
15	Madura	" 16–17	31	54.2	127	02
16	Norseman	" 25	32	12.2	121	48
17	Moora	July 22	30	38.0	115	59
18	Rabbit-Proof Fence 2	Aug. 2	31	39.0	118	42
19	Rabbit-Proof Fence 3	" 4–5	30	23.4	118	32
20	Dromedary Hill	" 5–6	29	02.1	118	27
21	Cue	" 8	27	25.6	117	53
22	Meekatharra	" 11	26	35.2	118	30
23	Peak Hill	" 12–13	25	37.6	118	44
24	Bald Hill	" 14–15	24	49.5	119	36
25	Mundawindi	" 16	23	53.4	120	10
26	Ethel Creek	" 17	22	54.5	120	10
27	Nullagine	" 20	21	53.0	120	07
28	Marble Bar	" 27	21	11.4	119	44
29	Port Hedland	" 31	20	18.7	118	35
30	Ballaballa	Sept. 2–3	20	41.4	117	49
31	Broome, *A*	" 7	17	58.3	122	13
32	Derby	" 9–10	17	17.8	123	38
33	Port George IV	" 24–26	15	21.1	124	43
34	Montgomery Islands	" 28–29	15	53.7	124	18
35	Sunday Island	Oct. 4	16	24.5	123	12
36	Broome, *B*	" 12–13	17	58.1	122	13

W. C. PARKINSON, ON MAGNETIC WORK IN THE ISLANDS OF THE PACIFIC OCEAN, JANUARY TO DECEMBER 1915.

The work outlined for 1915 according to instructions of the Director, dated December 16, 1914, and supplemented by instructions of July 2, 1915, consisted in a series of expeditions to various island groups in the south Pacific. As carried out, the work may be divided into the following subdivisions:

I. Jan. to Mar., New Caledonia, New Hebrides, and adjacent islands.
II. Apr. to Aug., Fiji, Samoa, Gilbert, and adjacent groups.
III. Aug. 31 to Oct., Solomon Islands.
IV. Oct. to Dec., New Guinea and neighboring islands.

I. On January 20, 1915, I left Sydney for New Caledonia, arriving at Noumea January 25, with instrumental outfit consisting of universal magnetometer No. 14, pocket chronometer No. 258, and miscellaneous accessories. I was most courteously received by the Governor-General, who offered me all necessary assistance and gave me permission to make observations in any part of the islands. After making a short trip along the west coast of New Caledonia to Bourail and Paagoumene, and finding that the steamer *Pacifique* by which I hoped to reach Fila in the New Hebrides had been delayed so that I could not expect to catch the English boat north at the latter point, I took advantage of the opportunity to visit Walpole Island in a steamer chartered by the Austral Guano Company of Melbourne. This was made possible through the kind invitation of Captain Cousins, Island Manager of the Company, who is keenly interested in the practical assistance to navigation given by magnetic surveys. Walpole Island is uninhabited and extremely rugged, and as the only means of landing (see view 1 of Plate 7) was by scaling an overhanging rock from an open boat, the landing of a heavy cargo from practically open sea was difficult and slow. I made observations at convenient times during the steamer's stay and returned to Noumea on February 10.

An opportunity to visit a few points among the Loyalty Islands was afforded by the sailing of the three-masted schooner *Trois Isles* from Noumea February 12. The schooner touched at Lifu and proceeded to Uvea where I left it and awaited the steamer *Saint Pierre* which picked me up and took me back to Noumea after giving a further opportunity to make observations at Lifu, and calling at Maré Island where sufficient time was allowed during the stop for a complete magnetic program. In general the length of time allowed during the call of a cargo vessel at the smaller ports is insufficient for satisfactory work, and unless a long delay between stations is warranted, an abbreviated program must be adopted. In returning by way of Lifu the second opportunity made it possible to secure observations of all the elements at that point.

Arriving at Noumea, I found the *Pacifique* at her wharf on her way to Fila, Sandwich Island, in the New Hebrides, and I therefore went aboard and left Noumea finally the next day, February 21. After calling briefly at Fila and at Diamond Bay, the *Pacifique* was caught in a gale which developed into a hurricane, and after battling against it for 18 hours was forced to put into Port Sandwich for shelter. While making use of a short interval here to get a few incomplete observations, I was agreeably surprised to see the English boat, the *Makambo*, which I supposed I had missed, put into the harbor, likewise seeking shelter. I therefore immediately transshipped to the *Makambo* and took passage with her to Sydney by way of Banks Islands, Fila, Norfolk, and Lord Howe Island. As the vessel was already nearly 5 days behind her schedule, the captain was anxious to make up as much of the time as possible, and it was evident that in view of the short stoppages at each trading station, complete or even half-sets of observations would be out of the question, so I decided that the only way in which I could secure the necessary distribution over the area covered was to confine my attention at each station to a single element, taking them in turn so that a complete determination would be secured in as small an area as possible. Every opportunity was used to secure whatever was possible, having in mind the volcanic nature of the islands and the consequent possibility of local disturbance. The landings were made in every case by small boats often through treacherous surf, and many times I got ashore only to find that the shipping of the copra would take only a few minutes, leaving no time for any sort of observations. The captain and his officers were ready to afford me every possible assistance, and but for the necessity of making up his time already lost, would readily have given me greater opportunity for my work. In only one case did I have opportunity to make a complete set of observations, that being at Aoba Island, where the steamer left me in the morning and called again that evening after visiting another station.

Rough weather was encountered during the passage from Fila to Norfolk Island and on arrival there it was found impossible to land on the south side at the town, and accordingly I got ashore on the north coast and made a full set of magnetic observations during a strong southerly wind. The passage to Lord Howe Island was even worse, the wind rising to the force of a gale, so that the vessel missed the island in the night, being blown out of her course, and returned after daylight. Here again the southern anchorage was untenable, and, during the few hours stop, I got ashore on the north shore and made a half-set of observations.

I returned to Sydney March 22, having been out 64 days, during which 20 stations had been occupied, some very incompletely, and having traveled approximately 6,100 miles, most of which was by steamer. The cost per station of the 20 stations occupied, exclusive of the observer's salary, was about $12.50.

II. Leaving Sydney on April 28, I went by way of Auckland, New Zealand, first to Fiji Islands, where I reoccupied the secular variation station at Suva, and then to Apia, Samoa, making observations at stops en route in the Tonga Islands. At Apia, which was reached on May 13, comparisons were made with the standard instruments of the Samoa Observatory, May 17 to 21, 1915.

On May 21 the *John Williams*, the London Mission ship, arrived, and I was taken aboard for a cruise among the islands of the Tokelau, the Ellice, and the Gilbert Island groups. Stations were occupied at landings as opportunity offered, the itinerary being indicated by the order and dates of the stations in Table 26. Some of the stations would be difficult of access by means other than that employed, as seen by the fact that at one island we picked up a government official who had been stranded there for 3 months owing to lack of communication. I went ashore at Ocean Island on May 28 to inquire about steamer service to the Marshall Islands and learned that, owing to conditions arising from changes incident to the war, formerly established communications had been greatly modified or discontinued. The result of my inquiries made it evident that it was not expedient to undertake to reach the Marshall Islands, and that it would be best to remain with the *John Williams*, on her return journey, a proposition to which the captain readily assented. Scant time for observations was afforded at many of the stops and at others rough seas prevented a landing for observations, though by making use of such opportunities as arose some good results were obtained.

We returned to Sydney on August 3 after a stormy passage. The time consumed on this section of the work was 105 days, during which 28 stations had been occupied, after traveling nearly 12,000 miles, the average cost per station being (exclusive of observer's salary) but little more than $10. This low cost is in large measure due to the courteous and hospitable treatment accorded by the Australian Ship Committee of the London Missionary Society, and to the officers and crew of the *John Williams*, who rendered every assistance in their power to make the trip a pleasant and profitable one.

Had the weather been less favorable, many of the stations could not have been reached, as landings would have been impossible. On account of the prevailing easterly winds, most of the landings were made on the west side of the islands, and because of the dense groves of coconut palms, observations on the sun could rarely be made except in the afternoons. There were but few permanent reference-objects that could be noted in descriptions of stations. The native huts are in general light and portable and offer little prospects for permanency.

III. I left Sydney aboard the *Mindini* on August 31, for a short trip among the Solomon Islands. Anchor was dropped in Tulagi Harbor on the evening of September 9. Between that date and September 25 I traveled with the steamer as she moved about the groups to the scattered trading stations, occupying stations as indicated in Table 26. View 5 of Plate 7 is a typical station. The conditions of work were very similar to those

described in connection with the work in the New Hebrides, with the obvious disadvantage of attempting observations during the brief and uncertain intervals allowed ashore. The captain and officers of the *Mindini* afforded all the assistance they were able, and with their cooperation I succeeded in establishing 10 stations within a field time of scarcely more than 15 days, and at an average cost of a little less than $11 per station.

IV. Leaving Sydney on October 13 under authority of the general instructions of the Director, dated December 16, 1914, and more specific instructions cabled on October 5, 1915, I proceeded to Port Moresby, British New Guinea, for work along the accessible portions of the coast and islands of the adjacent archipelagoes. After visiting Samarai and Woodlark Island aboard the *Morinda*, we returned to Port Moresby, calling at Yule Island en route. It had been hoped that a schooner could be obtained with which to make an extended trip of about 6 weeks along the coast of Papua, but after several attempts to secure a suitable vessel the plan was abandoned. I then went aboard the *Misima*, which left Port Moresby, November 5, for Thursday Island, where I was able to reoccupy the station of 1911, during November 11 to 13, returning to Port Moresby the following week after visiting Daru Island and Bramble Cay, a small sand island of a half-acre in extent, at which the steamer made a special stop to allow brief observations. Proceeding eastward with the *Misima*, I obtained observations at Delami Island and Suau Harbor on November 20, the steamer having made special stops at both places for that purpose. The following day at Samarai, I learned on inquiry that there was small chance of the Rabaul steamer calling there on her way north; I therefore remained aboard the *Misima*. After visiting Misima Island, the vessel proceeded to cruise among the islands off the eastern end of Papua (New Guinea) and along the northern coast. She made a special call at Panasesa Island to enable me to make observations, and put in to Doini Island the following morning at about 3 o'clock for a cargo of seed coconuts. During the loading of these I made an incomplete set of declination observations by moonlight.

The steamer arrived at Mambare at the boundary of British New Guinea and Kaiser-Wilhelms Land on November 29, where I made inquiries as to the prospects of getting along the German coast to Madang, and thence to points on New Britain in the Bismarck Archipelago. The only service in operation was found to be a German steamer, at that time used by the Australian forces of occupation as a patrol boat, and its movements were extremely uncertain. I decided, on the advice of those who understood the situation locally, to remain with the *Misima* as far as Buna Bay, where there was an unengaged motor-launch that might be obtained for reaching the coast points as far as Madang. The owner of the launch proved to be unwilling to rent it except at a charge disproportionate to the value of the work that could be accomplished.

I finally quitted the *Misima* at Samarai on December 2, after nearly a month aboard, during which I had occupied 18 stations more or less completely, several of which would have been impossible but for the special stops which Captain Brown very kindly made to allow me the opportunity for work ashore. I remained at Samarai until December 6 when the *Morinda* called on her way to Rabaul, where I worked while the steamer visited nearby ports. Unfortunately the *Matunga*, with which I hoped to connect for Madang and points in New Britain and New Ireland, had left 2 days earlier in order to complete her work and return to Sydney before Christmas. As I could learn of no other immediate possibility for reaching the desired regions, I rejoined the *Morinda*, and returned to Port Moresby, and thence to Sydney, where we arrived in the early morning of December 24, 1915.

The total number of days required for this section of the work was 53, nearly 8,200 miles had been covered, and 23 stations occupied more or less completely at a cost per station exclusive of the observer's salary of about $13.50.

The amount of work accomplished was limited in large measure by the abnormal conditions of transportation growing out of the war. Normally there had been steamers running between points in German New Guinea and the islands of the Bismarck Archipelago, but at the time of this expedition there was no such service, and the only alternative would have been to charter a schooner. The same conditions existed on the Dutch coast as well. As far as work in the interior of New Guinea is concerned, any attempt should be only by an organized expedition, consisting of at least 3 white men and a large number of native carriers. In this way it would be possible to cross the narrow neck between Port Moresby and Mambare in about 20 days. Launches run up the Fly River and also to the Lakakamu gold-fields at the head of the Aird River, at irregular intervals as business invites. No such opportunity occurred while I was there. As to the region farther west, it is largely unexplored and would doubtless present great difficulties of transportation.

Table 26 shows the stations at which magnetic observations were made, with dates of occupation and geographic positions; for values of the magnetic elements, see Table of Results.

TABLE 26.

No.	Name	Island or Group	Date	Latitude	Long. East
			1915	° ′	° ′
1	Noumea	New Caledonia	Jan. 26	22 16.3S	166 28
2	Bourail	New Caledonia	" 27	21 37.0S	165 29
3	Paagoumene	New Caledonia	" 30	20 29.2S	164 11
4	Walpole Island	Loyalty Islands	Feb. 6–8	22 37.0S	168 58
5	Lifu Island	Loyalty Islands	" 14–18, Aug. 3–4	20 46.8S	167 09
6	Uvea Island	Loyalty Islands	Feb. 16–17	20 38.0S	166 31
7	Maré Island	Loyalty Islands	" 19	21 32.6S	167 53
8	Diamond Bay	New Hebrides	" 23	16 47.2S	168 10
9	Port Sandwich	New Hebrides	" 24	16 25.6S	167 44
10	Tangice Island	New Hebrides	" 26	15 35.2S	167 01
11	Aoba Island	New Hebrides	" 28	15 23.0S	167 44
12	Kakea Island	New Hebrides	Mar. 3	13 50.3S	167 36
13	Tangoa Island	New Hebrides	" 5	15 35.3S	166 59
14	Tasariki	New Hebrides	" 5	15 37.4S	166 47
15	Pentecost Island	New Hebrides	" 7	15 51.3S	168 10
16	Tesman Bay	New Hebrides	" 8	16 17.0S	167 40
17	Ngala	New Hebrides	" 10	16 41.2S	168 17
18	Fila	New Hebrides	" 13	17 44.3S	168 19
19	Norfolk Island	Norfolk Island	" 18	29 01.7S	167 58
20	Lord Howe Island	Lord Howe Island	" 22	31 31.1S	159 04
21	Suva, *Dr. Klotz's Station*	Fiji Islands	May 8	18 08 8S	178 26
22	Nukualofa	Tonga Islands	" 9	21 08.1S	184 48
23	Lifuka	Tonga Islands	" 10	19 48.6S	185 39
24	Neiafu	Tonga Islands	" 11	18 39.0S	186 01
25	Apia, Samoa Observatory	Samoan Islands	" 17, 20	13 48.4S	188 14
26	Swains Island	Tokelau Islands	" 25	11 03.3S	188 55
27	Atafu Island	Tokelau Islands	" 27	8 32.4S	187 29
28	Funafuti Island, *A*	Ellice Islands	June 1	8 30.9S	179 12
29	Vaitupu Island	Ellice Islands	" 2, 11, July 14	7 29.4S	178 40
30	Nukufetau Island	Ellice Islands	June 3	8 00.7S	178 24
31	Nukulailai	Ellice Islands	" 4	9 21.9S	179 50
32	Funafuti Island, *B*	Ellice Islands	" 5	8 30.7S	179 12
33	Nui Island	Ellice Islands	" 7	7 13.9S	177 10
34	Nanomana Island	Ellice Islands	" 8	6 17.6S	176 20
35	Nanomea Island	Ellice Islands	" 9	5 39.8S	176 07
36	Niutao Island	Ellice Islands	" 10	6 06.5S	177 20
37	Peru Island	Gilbert Islands	" 14–26, July 5	1 18.7S	176 01

TABLE 26—*Concluded.*

No.	Name	Island or Group	Date	Latitude	Long. East
			1915	° ′	° ′
38	Nukunau Island........	Gilbert Islands....	June 15	1 19.9S	176 26
39	Arorai Island..........	Gilbert Islands....	" 17	2 38.7S	176 50
40	Tamana Island.........	Gilbert Islands....	" 19	2 30.2S	176 00
41	Onoatoa Island........	Gilbert Islands....	" 23	1 47.8S	175 33
42	Tapeteuea Island......	Gilbert Islands....	" 24	1 13.4S	174 46
43	Nonuti Atoll..........	Gilbert Islands....	" 25	0 47.7S	174 28
44	Ocean Island..........	Gilbert Islands....	" 29	0 52.8S	169 32
45	Apaiang Island........	Gilbert Islands....	July 1	1 51.0N	173 00
46	Maraki Island.........	Gilbert Islands....	" 2	2 00.2N	173 16
47	Tarawa Island.........	Gilbert Islands....	" 3	1 21.2N	172 55
48	Fakaofu Island........	Tokelau Islands...	" 19	9 23.0S	188 45
49	Makambo Island......	Solomon Islands...	Sep. 10, 23	9 04.9S	160 12
50	Tulagi...............	Solomon Islands...	" 10–11	9 06.6S	160 11
51	Kumbara Island......	Solomon Islands...	" 13	9 31.0S	160 33
52	Guadalcanar Island....	Solomon Islands...	" 13, 24	9 25.2S	160 17
53	Gizo.................	Solomon Islands...	" 15, 19	8 06.0S	156 61
54	Faisi Island...........	Solomon Islands...	" 16–17	7 04.5S	155 53
55	Binskin's Station......	Solomon Islands...	" 18	7 46 S	156 34
56	Simbo Island.........	Solomon Islands...	" 19	8 16.7S	156 32
57	Salicana Island.......	Solomon Islands...	" 20	7 26.6S	157 40
58	Warata Island........	Solomon Islands...	" 21	8 30.2S	158 03
59	Port Moresby, *A*......	New Guinea......	Oct. 23, Nov. 3, 5	9 29.1S	147 09
60	Samarai, *A*...........	New Guinea......	Oct. 25–26, 30, Nov. 21, 24, Dec. 2	10 36.8S	150 40
61	Woodlark Island......	New Guinea......	Oct. 27–28	9 09.2S	152 44
62	Yule Island, *A*........	New Guinea......	Nov. 1, Dec. 15	8 50.0S	146 33
63	Port Moresby, *B*......	New Guinea......	Nov. 4	9 28.1S	147 09
64	Thursday Island......	Australia.........	" 11–13	10 34.9S	142 12
65	Bramble Cay.........	Australia.........	" 15	9 08 S	143 52
66	Daru Island..........	New Guinea......	" 15	9 05 S	143 11
67	Yule Island, *B*........	New Guinea......	" 16	8 49.8S	146 33
68	Kapakapa............	New Guinea......	" 18	9 50.0S	147 31
69	Suau Harbor..........	New Guinea......	" 20	10 41.4S	150 15
70	Delami Island.........	New Guinea......	" 20	10 31.0S	149 48
71	Misima Island........	New Guinea......	" 22–23	10 41.2S	152 50
72	Panasesa Island.......	New Guinea......	" 23	10 44.0S	151 42
73	Doini Island..........	New Guinea......	" 24	10 41.6S	150 43
74	Kiagouam Island......	New Guinea......	" 25	10 22.4S	151 25
75	Entrance Island.......	New Guinea......	" 27	9 12.1S	152 25
76	Gawa Island..........	New Guinea......	" 27	8 59.6S	152 10
77	Kiriwina Island.......	New Guinea......	" 28	8 31.8S	151 00
78	Mambare............	New Guinea......	" 29	8 04.3S	148 01
79	Buna Bay............	New Guinea......	" 30	8 40.3S	148 25
80	Cape Nelson..........	New Guinea......	Dec. 1	9 03.3S	149 17
81	Ipoteto Island........	New Guinea......	" 1	9 38.0S	150 01
82	Kwato Island.........	New Guinea......	" 3	10 37.0S	150 38
83	Samarai, *B*...........	New Guinea......	" 6	10 36.7S	150 40
84	Rabaul..............	Bismarck Archipelago	" 9–10	4 12.7S	152 12

W. C. PARKINSON, ON MAGNETIC WORK IN NEW ZEALAND, FEBRUARY TO APRIL 1916.

Acting on the cabled instructions of the Director, I proceeded to Christchurch, New Zealand, where after consultation with Professor Coleridge Farr of the Canterbury College and Mr. H. F. Skey of the Magnetic Observatory a program of reoccupations and new stations in North Island and South Island was agreed upon.

After making observations at the Observatory and at the New Zealand magnetic station at Springfield, I left Christchurch for Dunedin and the southern lakes. Five stations were occupied in this section of South Island, three of which were approximate reoccupations of the stations of the New Zealand survey. I returned to Christchurch and went thence to Auckland, North Island, intending to establish a station on Great Barrier

Island, but found that the steamer made a complete circuit of the island with stops at various stations of not more than one or two hours, allowing no time for work, unless one were willing to remain on the island one week until the return of the vessel. The proposed trip to the island was, therefore, abandoned, and after reoccupying the stations of the New Zealand survey at Rotorua and Te Awamutu, I returned to the vicinity of Wellington where three other stations were occupied. There has been considerable change in the vicinity of each of the stations, so that exact reoccupations were not possible, but close reoccupations were usually obtained so that the results are probably good for secular-variation determinations.

The following table shows stations occupied in New Zealand, with dates of occupation and geographic positions; for magnetic data, see Table of Results.

TABLE 27.

No.	Name	Date	Lat. South		Long. East	
		1916	°	′	°	′
1	*Christchurch*	Feb. 27	43	31.8	172	37
2	Springfield	Mar. 2	43	20.6	171	57
3	Queenstown	" 6	45	02.1	168	42
4	Kingston	" 7–8	45	19.7	168	45
5	Manapouri	" 10–12	45	33.0	167	38
6	Te Anau	" 13	45	25.1	167	44
7	Clinton	" 15	46	12.6	169	26
8	Rotorua	" 25	38	07.9	176	16
9	Te Awamutu	" 28–29	38	00.4	175	20
10	Mt. Victoria	Apr. 3	41	18.7	174	47
11	Petone	" 4	41	13.5	174	53
12	Eketahuna	" 6–7	40	38.8	175	43
13	*Christchurch*	" 9–11	43	31.8	172	37

A. D. POWER, ON MAGNETIC WORK IN VENEZUELA, COLOMBIA, PERU, AND BRAZIL, MARCH TO OCTOBER 1914.

Acting under instructions dated February 26 and March 9, 1914, I left New York on March 11 for Caracas, Venezuela, with instrumental equipment as follows: universal instrument No. 21 with dip needles 3 and 4 of 19 and 3 and 4 of 20; pocket chronometer No. 260, small box-chronometer No. 677, three watches, also various accessories, including thermometers, compass, tent, tape, tripod, tool kit, etc. Caracas was reached March 20 and a few days were spent there obtaining information concerning various routes, reoccupying magnetic station, and transacting other business matters of the expedition. The route decided upon from Caracas to Bogota and which was followed was first an overland journey to San Fernando de Apure, at which point the river travel began, going first down the Apure River to its junction with the Orinoco, following the Orinoco up to the mouth of the Meta River, thence ascending the Meta River into Colombia as far as possible, making the stage overland to Bogota.

The trip of 300 miles from Caracas to San Fernando de Apure was made between March 25 and April 5, taking 5 hours by train to Cagua, 3 hours by coach to Villa de Cura, and the remainder by mule cart. Parts of the trail were very good and other parts almost impassable. The dryness and intense heat also added considerable discomfort, making night travel necessary. The trip from San Fernando on the Apure River to Orocué, Colombia, on the Meta River, a distance by river of over 550 miles, began April 12 and ended May 22. Navigation by steamer or launch being impossible at the time, arrangements were made to use a large canoe fitted with a sail. The trip down the Apure River to the Orinoco was against the strong easterly wind and required about 4 days, but ascending the Orinoco with the strong wind favorable, it required only a little over one day to reach La Urbana on the Orinoco, where the station of 1913 was reoccupied.

Within a day after leaving La Urbana, the strong wind of the dry season failed and the remaining distance up the Orinoco and practically the whole of the long distance up the Meta River to Orocué was covered by poling. As the boat was rather heavy and the Meta soon began to rise with a strong current, due to the advance of the rainy season, the travel was very difficult and slow, 12 or 15 miles being a good day's travel. The breaking of a rope while hauling the boat up through rapids at Cariben near the mouth of the Meta fortunately did not result in disaster. Toward the latter part of the traveling to Orocué, the question of food for the boatmen became serious, as the journey had taken more time than had been expected, and there had been no opportunity of obtaining additional provisions along the river, there being no inhabitants for about 300 miles below Orocué. However, a lighter canoe was secured at Orocué, enabling us to make the trip of 180 miles to Barrigon between May 26 and June 7.

The ride by mule from Barrigon to Villa Vicencia required 3 days, part of which was very slow going through deep mud, swamps, lagoons, rivers, etc. The 3 days from Villa Vicencia to Bogota, where we arrived June 18, was on a rough mountain trail (see views 1 and 2 of Plate 6). At Bogota several days were required to obtain information concerning practicable routes to the Amazon, and to attend to various other matters of the expedition. At the time of leaving Bogota, the exact route to the Amazon had not been selected, as more information was required before making a final decision.

The trip by rail from Bogota to Girardot was made on June 30, leaving 2 days there for reoccupation of station and diurnal-variation observations before catching the weekly steamer on July 3 for Purificacion. Work was prevented on July 1 and 2 by an attack of malaria, and as it seemed inadvisable to delay a week, the station at Girardot was not reoccupied. On July 7 we rode to Neiva by mule from Purificacion. The magnetic station of 1909 was reoccupied, and the route to Putumayo River via Caqueta River decided upon. The trip by mule from Neiva to Florencia was made between July 10 and July 17. The travel from Purificacion to Guadalupe was through a hot, dry, dusty valley; the remainder, between Guadalupe and Florencia, was wet mountain travel.

A small canoe, 2 boatmen, and a servant were engaged at Florencia, and the trip by river began July 20. The Rio Orteguaza was followed to the Rio Caqueta, which was reached July 25. A more direct route from this point to the lower Putumayo is to follow down the Caqueta 8 days to Las Delicias, make a 3-days' portage to the Rio Igara-Parana, and follow this river to the Putumayo. This route, however, could not be followed, as the Colombian boatmen feared the Peruvian soldiers at Las Delicias. From the mouth of the Rio Orteguaza the Rio Caqueta was descended one-half day to the mouth of the Rio Micaya, then this river was ascended 6 days to an Indian camp from which there was a trail to the Putumayo. The 2 boatmen alone made such slow progress up stream that all members of the party were compelled to help. Upon arrival, July 31, the Indian camp was found deserted, and Indians to carry luggage could not be found before August 12, when the portage began. The portage, even under the best conditions, is a very poor trail. It was rendered much worse by heavy rains and the last of the luggage did not reach the Putumayo until August 16. A canoe then carried us down stream to La Reforma in 3 hours.

As boatmen could not be secured from the scanty population along the river, a canoe and a supply of provisions were purchased, and I started down river with one servant on August 18. El Jubineto, the Peruvian outpost, was reached August 22, where an escort of soldiers was kindly provided to accompany me to El Encanto, which we reached August 27. A launch was then taken to the mouth of the Rio Igara-Parana, where the canoe traveling was resumed as before for 17 days to the Amazon, which was reached September 17. Stations were occupied along the entire route from Florencia to Santo Antonio do Içа at the mouth of the Putumayo, or Iça River.

On September 20 the opportune arrival of a river steamer enabled us to reach Manaos September 24, where passage was secured direct to New York on a steamer which made a stop at Para sufficient to allow the reoccupation of the secular-variation station at Pinheiro. I returned to the Office on October 17, after an absence of 220 days during which 38 stations had been occupied.

Table 28 gives a list of the points occupied, together with dates and geographic positions; the magnetic data are given in the Table of Results.

TABLE 28.

No.	Name[1]	Date	Latitude		Long. East	
		1914	°	′	°	′
1	*Caracas*	Mar. 23	10	30.4N	293	04
2	Villa de Cura	" 26	10	02.2N	292	30
3	Ortiz	" 29	9	37.5N	292	43
4	Calaboza	Apr. 1	8	56.1N	292	34
5	Medana del Burro	" 3	8	24.6N	292	25
6	San Fernando de Apure	" 7	7	53.9N	292	32
7	Apure River	" 15	7	39.8N	293	17
8	*La Urbana*	" 17–18	7	08.3N	293	01
9	Guaramaco	" 23	6	14.6N	292	33
10	Mata de Guanabano	" 28–29	6	12.2N	291	47
11	Meta River 1	May 4	6	10.8N	291	13
12	Meta River 2	" 9	6	02.5N	290	29
13	Meta River 3	" 13	5	36.6N	289	54
14	Meta River 4	" 17	5	21.9N	289	26
15	Orocué	" 23	4	47.8N	288	46
16	Culate de Pupures	" 29–30	4	28.0N	288	12
17	Remolino de Migel	June 4	4	17.2N	287	29
18	Barrigon	" 8	4	10.4N	287	04
19	Villa Vicencia	" 13	4	08.9N	286	29
20	*Bogota*	" 26	4	37.6N	285	54
21	*Neiva*	July 8	2	55.5N	284	35
22	Guadalupe	" 14	2	01.3N	283	59
23	Florencia	" 18	1	36.3N	284	04
24	Bella Vista	" 22	1	09.5N	284	11
25	La Victoria	" 24	0	44.6N	284	27
26	El Baradero del Micaya	Aug. 2–4	0	22.6N	284	06
27	La Reforma	" 17	0	03.7S	284	15
28	El Jubineto	" 22–23	1	00.2S	285	30
29	El Encanto	" 28	1	37.7S	286	29
30	Boca del Tupache	" 31	2	21.2S	287	04
31	Putumayo 1	Sep. 1–2	2	11.4S	287	52
32	Putumayo 2	" 5	2	17.3S	288	54
33	Putumayo 3	" 8	2	39.0S	289	36
34	Putumayo 4	" 11	2	52.5S	290	27
35	Putumayo 5	" 14	2	58.5S	291	02
36	Santo Antonio do Iça	" 17–18	3	06.2S	292	00
37	*Manaos, II*	" 25	3	07.6S	299	58
38	*Pinheiro, A*	Oct. 1	1	17.9S	311	31

[1] The stations are located in the following countries: Nos. 1 to 9, Venezuela; Nos. 10 to 27, Colombia; Nos. 28 to 33, Peru; Nos. 34 to 38, Brazil.

The average time in the field was about 5 days for each station; this average was rather high because of slow travel up the Meta River; the roundabout route necessary from the Rio Caqueta to the Rio Putumayo, and the delay in making the portage increase the average. The total distance traveled was approximately 9,800 miles, of which 6,350 miles were to and from field and 3,450 miles in field, making an average field travel for each station of 91 miles. The average field expense for a station was about $51.

No marked local disturbances were found, but near the Andes the values appeared more irregular than on the more level land to the eastward.

Throughout the entire trip, United States officials, local government officials, and private individuals were all very courteous and helpful.

H. E. SAWYER, ON MAGNETIC WORK IN FRENCH WEST AFRICA, GUINEA COAST, AND NIGERIA, JULY 1913 TO NOVEMBER 1914.

Acting upon the instructions of the Director dated September 12, 1912, and those of Mr. D. W. Berky, chief of party, I left Timbuktu July 21, 1913. The instruments consisted of universal magnetometer No. 20, pocket chronometer No. 254, watch No. 8282, and miscellaneous appurtenances, all of which had been in use since leaving Algiers in October 1912.

The general route followed was up the Niger River, across the inland railroad to the Senegal, down that river to the coast, thence southward around the coast to Lagos, Nigeria, making inland trips on the railroads in Ivory Coast, Gold Coast, and Togoland. From Lagos the route followed the railroad to Kano, then eastward overland to the Benue River, ascending it as far up as it is navigable to Garoua south of Lake Tchad, then down the Benue and Niger Rivers to Forcados. At Timbuktu, at the conclusion of the Trans-Saharan expedition (for an account of which see Volume II of these *Researches*, pages 68 to 79), the party was divided, Mr. D. W. Berky, who had been in charge of that expedition, going south down the Niger to Dahomey and thence by rail to Cotonou, while I was put in charge of a party to make our way westward to the Atlantic. Mr. Berky left Timbuktu the evening of July 20, 1913, on the 7-mile march to Kabara (Cabaret) on the Niger; I followed the next morning with a donkey caravan, and embarked at the same place. As his barge swung around and floated down-stream, the black punters of my barge began pushing it up-stream. When conditions were favorable, the barge was towed by a grass rope nearly 100 yards in length, which was later replaced by a new rope for which the boatmen exchanged a liter of crushed salt crystals.

The first station occupied was at Niafunké on July 26, and as evidence that we were leaving the desert behind we heard for the first time the roaring of lions roaming. Gourao, on the banks of Lake Debo, about 300 kilometers from Timbuktu, was occupied July 30. Coming across this lake was the first river steamer of the season bound down-stream. Several of the crew were wading ahead in water less than waist deep, trying to find sufficient depth for the steamer, which would often attempt a course and proceed a short distance only to become grounded, making it necessary then to turn to one side or back for another attempt. Assisted by a fair and favorable breeze our barge made rapid progress.

On approaching Mopti signs of increasing vegetation are more in evidence. Near the landing place a chained lion was pacing along the flat mud roof of one of the shops, gently growling as the horses or sheep passed in the street beneath him. Rice grown in the surrounding country was for sale in the markets in large quantities. A dike protecting the rice fields extends 7 miles across to rising ground on the south. Its crown, lined with 2 rows of young trees, makes a pleasant drive, which is evidence of advancing civilization. On August 8 the magnetic station Keé was made on the site of a deserted village. Segou station, where one of the few cotton gins of French West Africa is located, was occupied on August 15.

We arrived at Koulikoro on August 21, just a month after leaving Timbuktu. This is the eastern terminus of a railway by which the overland journey across the divide between the upper Niger and the upper Senegal is made. The more convenient and expeditious mode of transportation is reflected in the better class of buildings; the brick houses, with their tiled roofs, doors, floors, and glass windows, being a conspicuous contrast to the mud and straw houses with which we had become so familiar since emerging from the desert. At this point the welcome change in our mode of travel from barge to railway was made. The palace of the Lieutenant-Governor is located an hour's ride by rail from Koulikoro at Bammako, where one finds a thriving city of fine buildings, parks, ice and electric plants, printing offices, barbers, and other civilized conveniences.

It was while at Kita on September 2 that we had the first of the tropical rains. Kita was formerly the eastern terminus of the railroad, and the scene of numerous and severe troubles with the natives. A long shed near the residency housed the motor-lorries which the government used in transporting to the Niger before the extension of the railway to Koulikoro. Mahina, the railroad station near the large native town of Bafulabé, where the brick-yards which supply the brick and tiles for all building east of this point are located, was reached September 6, and Kayes, the highest point of navigation on the Senegal River, was reached September 16. Under ordinary conditions, ocean-going steamers (branch boats) come up to the latter place in the rainy season. This year, because of so little rain, only one steamer reached Kayes. The railroad extends about 50 kilometers down the river to Ambidi, and at this point I had expected to take the mail steamer *Barni* for the remainder of the journey to the mouth of the river. After some delay, word was received that the steamer was aground and would be unable to ascend higher than Bakel. I, therefore, secured a barge and the necessary provisions, and succeeded in reaching Bakel at noon September 25. We left Bakel on Saturday, September 27, for the trip down river to Matam, where we arrived on the afternoon of the following Tuesday, having spent all of Sunday and a portion of Monday stranded in the shallow waters of the river. Advantage was taken of the departure of the steamer *Dioula* to proceed to Podor, where an additional station was occupied before the return of the *Barni* upon her succeeding trip, by which I traveled to St. Louis. The magnetic station at Matam, which was occupied on October 2, is probably within 300 meters, and that at Podor within 30 meters, of de Vansaay's stations of 1895. In the dry season it requires 3 months to make the trip down the Niger by barge from the terminus of the railroad at Ambidi to St. Louis because of the low condition of the water in that season. The barge must be moved on wooden rollers from one water-hole to the next.

After reaching St. Louis on October 20, I proceeded by rail to Dakar, where I arrived the following day, and was disappointed to discover that owing to my delayed arrival my personal and official mail had been returned by the postal authorities to Washington. From Dakar the 2 Arabs who had been our guides on the desert expedition were returned to Biskra, Algeria, by way of Marseille. After exactly reoccupying the 1912 station at Dakar, I went to Bathurst, Gambia, where the 1912 station was closely reoccupied, and returned to Dakar in order to secure passage for Monrovia, Liberia. Monrovia was reached on December 18 and observations made at approximately the same point as that occupied by the *Goldfinch* in 1905, opportunity having been afforded on the passage of making observations at Bissao and Bulama in Portuguese Guinea. From Monrovia I made my way along the coast eastward to Lagos, Nigeria, making stops at Grand Bassam, Sekondi, and Lome, from each of which points inland trips were made over the railroads to their respective termini.

Work in Nigeria began after arriving in Lagos March 15. Mr. Berky's station of 1913 was reoccupied, and various stations were made along the railroad to its terminus, Kano. Returning to Zaria on the railroad, I went to Jenjere by the narrow-gage branch which taps the tin-mine district of the Bauchi plateau, and finished arrangements for the overland trip to Yola. During the first part of this trip to Bauchi, the outfit was carried by donkeys, after which native carriers were used. From Bauchi to Shillem the natives were very poor and conditions seemed to threaten an immediate famine. Guinea corn was the only food available for both man and beast. Jimeta, the small native town and port of Yola, was reached June 10. Marching up the Benue River with carriers, I arrived at Garoua, Cameroun, on the night of June 20. Having completed magnetic observations, I started back on June 24.

A steel barge manned by 10 native punters was used for the descent of the Benue to Ibi, with intermediate stops at Lau and Amar. When there is high water, barges

TABLE 29.

No.	Name[1]	Date	Latitude		Long. East	
		1913–14	°	′	°	′
1	Niafunké	July 26	15	56.0N	356	00
2	Gourao	" 30	15	18.3N	355	59
3	Mopti	Aug. 3	14	30.1N	355	47
4	Keé	" 8–9	13	57.1N	354	36
5	Segou	" 15–16	13	26.5N	353	42
6	Koulikoro	" 21–25	12	51.7N	352	26
7	Kita	Sep. 2–3	13	02.1N	350	28
8	Mahina	" 6–7	13	45.4N	349	07
9	Kayes	" 16–20	14	26.9N	348	34
10	Bakel	" 26	14	54.3N	347	33
11	Matam	Oct. 2	15	39.1N	346	45
12	Podor	" 12–13	16	39.3N	345	03
13	*Dakar*	Nov. 26–27	14	42.0N	342	35
14	*Bathurst, B*	" 30	13	27.2N	343	24
15	Bissao	Dec. 11	11	51.5N	344	26
16	Monrovia	" 20–26	6	18.7N	349	09
17	Grand Basa	" 29	5	52.2N	349	56
18	Greenville (Sino)	" 31, Jan. 2–7	5	00.6N	350	55
19	Cape Palmas, Russwurm Is.	" 12–13	4	21.6N	352	16
20	Grand Bassam	" 19	5	11.8N	356	19
21	Dimbokro	" 24–25	6	38.5N	355	12
22	Bouaké	" 27	7	42.0N	354	58
23	Abidjan	" 31	5	19.1N	356	00
24	Sekondi	Feb. 6	4	56.2N	358	18
25	Dunkwa	" 8	5	57.5N	358	15
26	Kumasi	" 10–11	6	41.0N	358	26
27	Elmina, *A*	" 15	5	04.8N	358	39
28	Accra	" 23–26	5	32.5N	359	49
29	Lome	Mar. 5	6	07.4N	1	16
30	Kpandu	" 8–9	6	59.9N	0	18
31	Palime	" 11	6	54.4N	0	39
32	Lagos, *A*	" 17	6	26.9N	3	24
33	Lagos, *B*	" 22	6	26.9N	3	24
34	Ibadan	Apr. 2	7	23.2N	3	53
35	Oshogbo	" 4	7	45.9N	4	33
36	Ilorin	" 7–8	8	30.4N	4	35
37	Jebba	" 10	9	07.7N	4	49
38	Zungeru	" 15–16	9	48.5N	6	10
39	Serikim Pawa	" 24–25	10	02.5N	7	07
40	Kaduna	" 26–27	10	29.2N	7	25
41	Kano	May 1–2	12	00.9N	8	33
42	Zaria	" 5	11	06.8N	7	43
43	Jenjere	" 9–11	10	14.5N	8	50
44	Bauchi	" 19	10	18.3N	9	49
45	Kwagal	" 26	10	16.9N	10	37
46	Debba Habe	" 31	10	12.8N	11	24
47	Shillem	June 6	9	53.4N	12	03
48	Jimeta	" 12–15, July 4	9	16.7N	12	29
49	Garoua	June 22–23	9	17.4N	13	24
50	Lau	July 10	9	12.9N	11	19
51	Amar	" 15–16	8	40.9N	10	23
52	Ibi	" 20–29	8	10.8N	9	44
53	Abinsi	Aug. 3	7	45.3N	8	45
54	Loko	" 12	7	59.8N	7	50
55	Lokoja	" 21, 23, Sep. 3	7	48.3N	6	44
56	Baro	Aug. 28	8	37.0N	6	23
57	Idah	Sep. 13–17	7	06.4N	6	43
58	Onitsha	" 27–28	6	10.6N	6	46
59	Abo	Oct. 2–5	5	32.0N	6	33
60	Forcados	" 30	5	22.9N	5	22

[1] The stations are located in the following countries: Nos. 1 to 13, 20 to 23, 29, 31, French West Africa; No. 14, Gambia; No. 15, Portuguese Guinea; Nos. 16 to 19, Liberia; Nos. 24 to 28, 30, Gold Coast Colony; Nos. 32 to 48, 50 to 60, Nigeria; No. 49, Cameroun.

will not go below Ibi, so I was compelled to wait for the next steamer, which arrived July 31, and Abinsi was reached August 3. Confirmation of the news of the declaration of war was found in the crowded conditions of the boats, which made it difficult to secure passage. Lokoja, at the junction of the Benue with the Niger River, was finally reached on August 16.

Ascending the Niger River in a steamer to Baro, I occupied a station there August 28, and returned to Lokoja. Continuing down the Niger, stops were made at Onitsha and at Abo where I arrived October 1. The rains had greatly increased since leaving Lokoja and the supply of boats diminished as the government was using them for the transportation of troops to Yola and Garoua and for the operations against Douala. No regular mail service was maintained. On October 30 the Forcados station was occupied, and on November 5, I embarked for Plymouth en route to Washington.

Table 29 (see p. 185) gives a list of the points occupied, together with dates and geographical positions. The magnetic data for stations of 1913 are given in Volume II of these *Researches*, and those for the other stations are given in the Table of Results in the present Volume.

The total time in obtaining the observations was 500 days, including 36 days' travel to the Office, making an average of about 8 days per station. Approximately 6,000 miles were covered by field traveling, of which one-third was railroad, one-third ocean, one-fourth river, and one-twelfth bush travel. The average distance between stations is about 100 miles. The average field expense was about $51 for a station. The actual living expenses were very small in comparison with the cost of transportation.

The success of the expedition was contributed to by the Lieutenant-Governor of the Ivory Coast, who extended free transportation on the French government railroad in that colony; also by the courtesies extended by Mr. Cleminson, Director of Cadastral Surveys of the Southern Provinces, and Mr. A. S. Collard, Director of Survey of Northern Provinces, Nigeria.

H. E. SAWYER, ON MAGNETIC WORK IN SOUTHERN, CENTRAL, AND NORTHEASTERN AFRICA, DECEMBER 1915 TO DECEMBER 1918.

This expedition comprises preliminary work in Australasia, and a few stations in Asia at the conclusion of the more extended travels in Africa along the entire length of the continent from Cape Town to Suez. The more detailed narrative of the entire expedition is given under titles corresponding to the following brief outline:

I. Preliminary observations in Australasia, including intercomparisons of instruments in New Zealand and Australia before commencing the African work.

II. Repeat stations for secular variation in South and Southwest Africa, principally those of Dr. J. C. Beattie's survey of South Africa, with others of the Department of Terrestrial Magnetism along the west coast of Africa to the mouth of the Congo.

III. The Gabon expedition, going overland from Stanley Pool on the Congo River to the head waters of the Ogoué River and down this river to the Atlantic coast at Libreville.

IV. From the Congo to the Nile, going up the Ubangi River to Bangui, thence overland to the head waters of the Chari River, down that river to the region of Lake Tchad, and by caravan eastward across Dar Massalit, Dar Fur, and Anglo-Egyptian Sudan to Khartum.

V. Along the Nile River and Red Sea coast, first ascending the White Nile from Khartum to Gondokoro, then making an overland journey from Khartum to the Red Sea, concluding with a reoccupation of stations of the Egyptian Survey along the rail and river trip down the Nile to Cairo.

VI. Return to America via the Orient, going by way of the Suez Canal, Red Sea, India, and Japan, and observing at repeat stations along the homeward journey.

I. *Preliminary observations in Australasia.*—Following the instructions dated November 5, 10, and 19, I was transferred from the *Carnegie* to land duty. Field work was started upon the departure of the *Carnegie* from Port Lyttelton, December 6, 1915. My outfit comprised theodolite-magnetometer No. 17; Dover dip circle No. 223, with needles Nos. 1, 3, 5, 6; tripod; observing tent; kodak; and various other accessories.

After making comparisons with the recording instruments at Christchurch, and observing at 2 additional stations on South Island, I sailed for Sydney, arriving January 10, 1916. Intercomparisons with Mr. Parkinson's instruments were finished on January 31, but as most of the shipping from Australia was being sent through the Suez Canal, a passage could not be obtained to South Africa before February 19, when I was fortunate enough to secure half of the only cabin on the tramp steamer *Walton Hall*, sailing for Durban, Natal.

II. *Repeat stations in South and Southwest Africa.*—After reaching Durban March 20, 1916, I traveled by rail to Cape Town, where camp equipment, steel trunks, and other necessary articles were purchased and permission to observe in the recently conquered territory of Southwest Africa was secured. From Cape Town I went by sea to Walfish Bay, then by narrow-gage train to Swakopmund, which was reached April 19. The return was made by rail to Cape Town with stops at intervals to secure a suitable distribution of secular-variation stations, after which passage was taken on the Portuguese steamer *Beira*, which sailed on May 18 for Boma on the Congo. In this portion of the campaign 16 secular-variation stations were occupied, all being reoccupations of stations established either by the Department, or by Dr. J. C. Beattie in his magnetic survey of South Africa. Of the 16 stations 5 were between Durban and Cape Town, 7 in Southwest Africa, and 4 on the west coast of Angola, Spanish Guinea, and Belgian Congo. As the total of railroad travel in South and Southwest Africa was about 2,900 miles, the average distance apart of these repeat stations is approximately 250 miles; the field expense was about $40 each.

III. *The Gabon expedition.*—The trip from Boma to Matadi by river and to Kinshasa by rail was finished June 10, 1916. After an annoying but unavoidable delay at Brazzaville, I started July 31 on the 700-mile journey which was to lead north to Franceville and thence down the Ogoué River to the coast. Porters were employed. In the open country they carried the loads on their heads, but in the forest they carried them partly on the back and partly by a strap of bark across the forehead. Carriers average from 16 to 18 miles per day, and subsist entirely upon manioc or cassava. This food is soaked for several days, then boiled, and rolled in large dough-like loaves, wrapped in leaves, and may be purchased at all the villages. The men usually carried a supply for a day or more with them. The trail led to the water-shed between the Congo on the south and the smaller rivers of the Gabon, over a region of large sandy hills with very few inhabitants. There are no forests except in the immediate vicinity of the Congo and its large tributaries, until after crossing the divide and descending into the Ogoué basin. There one enters almost immediately into the great equatorial forest extending to within a few miles of the coast. The Ogoué River falls rapidly until it reaches Ndjolé, the head of steam navigation 200 miles from Cape Lopez. The scenery of the upper Ogoué is renowned throughout the colony. There are several large falls and numerous rapids which quite often contain small cataracts of 4 to 5 feet. Traveling is done in long narrow dugout canoes. A canoe which will carry a crew of 15 men is about 45 feet long and 3 feet wide, while a one-man canoe is 12 inches wide and 8 to 10 feet long.

Nineteen stations were occupied between Brazzaville and Libreville, which was reached September 25. In the next 13 days Libreville and Cape Lopez were reoccupied, and the return passage to Boma secured, at which place I arrived October 13. This station was again reoccupied, and I secured the services of Mr. F. G. Barwell, who joined the party at Boma November 2. The journey to Brazzaville was repeated, arriving November 15. Here the box-chronometer which had been loaned to me by the chief of the French Hydrographic Service was returned. The C. I. W. station at Brazzaville was again reoccupied, and also a French magnetic station on a neighboring hill.

The Gabon campaign took 105 days, during which time 31 stations were occupied, making an average of 3 to 4 days per station. Ocean travel and the two trips up the

Congo amounted to 1,280 miles, which, together with the 700 miles caravan and canoe travel, gives a total mileage of 1,980. The average travel for each station was 64 miles, but the average distance apart of the 26 stations occupied along the land route was 27 miles. The average field expense of the 31 stations was about $32.

IV. *From the Congo to the Nile via Lake Tchad.*—At Brazzaville tents were purchased, camping equipment renewed, and provisions selected which were intended for use in the desert country around Lake Tchad. On November 24, 1916, the journey which would eventually bring us to Egypt was begun. The Belgian state steamer *Brabant*, whose destination was Stanleyville, took us to Bolobo, the first stage of the trip, where we were delayed 2 weeks waiting for the French steamer bound for the Ubangi River. At all the stops between Bolobo and Bangui, the rivers were in such an exceptional state of high water that nothing remained above water except the officials' houses. All local travel was by canoe and no observation spots were available. Bangui was reached December 21. A delay of one month occurred here, in which the government authorities determined that it was impossible to go north of Lake Tchad toward Tripoli, but that the route east to Egypt would be permitted provided the British officials would grant the necessary permission to enter Anglo-Egyptian Sudan.

Leaving Bangui January 21, 1917, the portage to the Chari River was accomplished in 29 days, during which 8 stations were occupied. The baggage, provisions, and instruments were carried on the heads of native blacks, while we rode two horses purchased for the purpose. However, one horse soon died of sleeping sickness, which compelled each man to walk half of the distance. The worst part of the dreaded sleeping-sickness district was left behind on reaching Fort Crampel. At that place the government maintained a segregated refuge for stricken natives; they were given rations and permitted to rest undisturbed by the healthy natives until the end. Nearly 70 were there at the time, mostly children or very young adults. The journey from Fort Crampel to Fort Archambault on the Chari River was made in a steel canoe belonging to the Maison Hollandaise. From Fort Archambault to Fort Lamy, the same company maintained a fleet of large steel barges, the central sections of which had a shelter of grass matting. The crews of these barges propelled them by punting along the shallower parts of the stream. When necessary to cross the channels, they would paddle, always to the accompaniment of their native chants. At Fort Archambault, we were delayed 26 days waiting for the lower river boats.

Fort Lamy was reached April 19, 11 stations having been occupied since leaving Fort Crampel. At this point Mr. Barwell returned to the coast. Permission to enter Anglo-Egyptian Sudan was received through the French army radio station from Lieutenant-Colonel R. L. Saville, the Governor of Dar Fur Province. The passage down the Chari and across the eastern arm of Lake Tchad in a launch of the Maison Hollandaise was completed May 5, 3 stations being established on the lower banks of the Chari. The trip from Lake Tchad eastward began May 9 and followed closely the same parallel of latitude. The district of Kanem east of the Tchad consists of stationary sand-dunes usually covered by some form of vegetation. Through it, running about northeast from the Tchad, is an ancient watercourse called the Bahr-el-Ghazal. Throughout the Kanem the water in the dry season comes from shallow wells where the earth formation under the sand forms a pocket and holds the water. It is a grazing country, and herds always collect around the water-holes, as a result of which the water is discolored and polluted. This condition exists as far eastward as Abeché, but to a lesser extent. After passing Lake Fitri the surface becomes less sandy, rocks are occasionally exposed, and wells are slightly deeper. Just north of this lake is a huge rock mass which can be seen for many days' travel through the surrounding flat country. It was the first rock we saw after leaving the upper Chari. The Tchad basin gives one the impression of having

been much deeper and of being gradually filled by sand blown from the barren highlands of the Sahara lying to the north and northeast. Oxen were used for transporting to Abeché. They would travel 15 miles in a day if they were in good condition; otherwise, 10 or 12 miles was the maximum. Water, or rather liquid, was obtained every day, and where there were inhabitants, large herds of cattle, goats and fat-tailed sheep were in evidence. Horses of an inferior breed are raised to some extent.

Abeché is the headquarters of Oudai and the starting point for government officials who go north and northeast into the rough country of Tibesti and Borku. There are many rocky prominences or masses of rock (''gebel'') between Abeché and El-Fasher in Anglo-Egyptian Sudan, and the divide which separates the Nile, Congo, and Tchad systems is flanked by rough country. The caravan was changed to camels at Abeché and at the end of one day's march east of Tountouma, the last French post, the mounted French troopers of my escort put me in care of 6 stalwart blacks dressed in flowing Moslem robes, who were soldiers of the Sultan of Dar Massalit. The only modern articles of their equipment were their French rifles and ammunition, which had been taken under the previous sultan, an uncle of the present one, when he annihilated two French columns sent against him. Subsequently, in Cairo, I learned that the British from El-Fasher had occupied this territory and installed a wireless station at Djenené, the capital of Dar Massalit. After 9 days within the boundaries of this independent kingdom, during which I established 3 stations, an escort of Anglo-Egyptian Sudanese troops or police arrived to accompany me to El-Fasher. The men were well mounted on horses, well bridled and saddled, and their trim uniform and respectful manner inspired no small confidence in their ability.

On September 7, I arrived at El-Fasher, Dar Fur, and was cordially welcomed by His Excellency, Lieutenant-Colonel Saville, the Governor, and by his staff. This province had been occupied by the troops one year before upon Sultan Ali Dinar's refusal to pay his annual tribute. The journey could not have been made across this territory before 1916. A delay was necessary here on account of a shortage of camels for transport, caused by the sultan's misrule and the recent military operations. When the camels had been provided, an attack of the malaria lengthened the delay here to 26 days. This portion of Anglo-Egyptian Sudan is not so productive as the French country recently passed through. The villages have little if any stock, and wells are much farther apart. The caravan averaged 25 to 27 miles per day.

At El Nahud, in the province of Kordofan, one sees the first of the marketing of gum arabic for which the province is famous. The gum exudes from the trunks and branches of scrubby trees after they have been gashed by the natives. Areas covered by these trees are referred to in government reports as gum gardens, and are also known as gum forests, but to the inexperienced these forests and gardens appear to be only the wilderness so frequently seen in many other parts of Africa. El Obeid, the capital of Kordofan, is the terminus of the railway which connects with the outside world. On this railroad is carried 75 per cent of the gum arabic produced in the world. Kosti, on the White Nile, was reached November 23. It was just one day less than a year since we left Stanley Pool, and in that time 77 stations were established, making an average of one station for every 4 to 5 days; 700 miles were covered by steamer transportation on the Congo, and 2,100 by boat and caravan, making 37 miles of travel per station. But one station was established from Stanley Pool to Bangui, so the average distance apart of stations on land travel was 27 miles. The average field cost of a station was about $32.

V. *Along the Nile River and the Red Sea Coast.*—Travel was continued by railroad to Khartum, which was reached November 29, 1917. Computations, medical and dental treatment, repairing of camping outfit, arrangements with the Steamers Department of

the Sudan Government for the hire of a sailing boat, and business details occupied the time to January 12, 1918. The journey of 1,100 miles to Rejaf, the head of navigation on the White Nile, and return was accomplished in an open boat, with a crew of 4 Arabs and one cook. This boat was equipped with a straw matting sunshade 6 feet long. On the return down stream, 7 continuous days and nights were spent in coming through the "bog" without landing. This was occasioned by one day's travel down the Bahr el Zaraf to the place where it was closed by floating "sudd," and 2 days' travel back to the Bahr el Gebel. Sixteen stations were occupied; 3 of which were stations of the Egyptian Survey Department, and one a reoccupation of Dr. Beattie's station at Gondokoro. Upon returning to Khartum on April 18, arrangements were immediately made to accompany Signor Pastori in an Italian government automobile truck to Asmara, Eritrea. Seventeen days were required for the journey, during which 4 stations were established. We arrived at Asmara, where the C. I. W. station was reoccupied, on May 11, and that at Massaua was reoccupied on May 19. Three days on a very small coasting steamer brought me to Port Sudan, where another C. I. W. station was reoccupied. The railroad journey by way of Atbara and Wadi Halfa on the Nile to Cairo, on which 9 stations were occupied, began May 26 and ended July 10. Most of them were reoccupations of Egyptian Survey stations. Intercomparison observations were carried out at the Helwan Observatory in July. Thirty-two stations were occupied in 249 days, which averages about 8 days for each station. The total number of miles traveled was 4,908, of which 2,241 were by steamer and railroad, and 467 by automobile. The average distance traveled per station was 149 miles; the average field expense of the work along the Nile, in Eritrea, and Red Sea Province was about $35 for a station.

VI. *Return to America via the Orient.*—Cable instructions to return to Washington via the Pacific route were received in Cairo. Passport and various official permits having been secured, and the Suez magnetic station having been reoccupied, the homeward voyage began August 29. Stations were reoccupied at Tor, Jidda, and Aden without any loss of time, but 2 days' change in the date of a ship from Aden to Jibuti caused me to miss connection with the French mail for China. During the wait at Jibuti, a railroad trip to Addis Abeba was made and observations secured near the station of 1914. On October 18, I departed from Jibuti, and after securing reoccupations of stations at Colombo, Singapore, and Yokohama, I arrived in San Francisco December 26, 1918. The homeward trip from Cairo covered 17,600 miles, and took 154 days.

Table 30 gives names of the stations occupied, with dates and geographic positions; for magnetic data, see Table of Results.

TABLE 30.

No.	Name	Date	Latitude	Long. East
	New Zealand	*1915*	° ′	° ′
1	*New Brighton Beach*	Dec. 10	43 31.6S	172 45
2	Cass	" 12–13	43 01.5S	171 48
3	*Christchurch*	" 19–24	43 31.8S	172 37
	Australia	*1916*		
4	*Red Hill, A, B*	Jan. 12, Feb. 1	33 44.5S	151 04
	British South and Southwest Africa			
5	Durban	Mar. 22–23	29 52.7S	31 04
6	*Ginginhlovu*	" 25–26	29 01.7S	31 35
7	Bethlehem	" 30	28 13.9S	28 17
8	Bloemfontein	Apr. 2	29 07.2S	26 12
9	*Cape Town, A*	" 9–10	33 56.1S	18 29
10	*Swakopmund*	" 20–22	22 41.0S	14 32
11	*Windhoek*	" 25–26	22 33.8S	17 05
12	*Gibeon*	" 28	25 07.2S	17 42
13	*Keetmanshoop*	" 30	26 34.7S	18 04

TABLE 30—*Continued.*

No.	Name	Date	Latitude	Long. East
	British South and Southwest Africa	*1916*	° ′	° ′
14	*Seeheim*	May 1–2	26 48.5S	17 44
15	*Aus*	" 4	26 40.3S	16 12
16	Upington	" 8–9	28 28 S	21 12
17	*Cape Town, C*	" 14–17	33 56.1S	18 29
	Angola			
18	*Mossamedes*	" 24	15 10.9S	12 09
19	*Loanda*	" 29	8 48.8S	13 14
20	*Cabinda*	" 31	5 32.3S	12 12
	Belgian Congo			
21	*Boma*	June 3–4	5 51.5S	13 04
	French Equatorial Africa			
22	*Brazzaville*	" 20–21	4 17.0S	15 17
	Belgian Congo			
23	*Leopoldville, A*	" 24	4 19.7S	15 14
	French Equatorial Africa			
24	Mayama	July 11	3 50.8S	14 53
25	Pangala	" 15–16	3 18.6S	14 31
26	Itinsi	" 19	2 57.2S	14 38
27	Djambala	" 22	2 33.0S	14 44
28	M'Pala	" 25	2 13.3S	15 10
29	Djambani	" 30–31	2 13.2S	14 30
30	N'Gobo	Aug. 4	2 04.4S	14 15
31	Ouala	" 8	1 58.8S	13 55
32	Franceville	" 11–12	1 38.0S	13 36
33	M'Boma	" 14	1 23.0S	13 20
34	Boukoussou	" 15–16	1 07.1S	13 12
35	Lastourville	" 18–21	0 48.2S	12 44
36	Missoko	" 23	0 37 S	12 30
37	Ivindo	" 26–27	0 09.2S	12 10
38	Boué	" 29	0 05 S	11 57
39	Junckville	Sep. 4–6	0 07 S	11 08
40	Ndjolé	" 9–10	0 10.8S	10 48
41	Massanza	" 13	0 25.4S	10 29
42	Lambarené	" 16–18	0 42 S	10 15
43	Ayemé	" 21–22	0 15 S	9 56
44	Chinchoua	" 24	0 00.6N	9 46
45	Libreville, *A*	Oct. 3–4	0 23.2N	9 27
46	Libreville, *B*	" 4	0 23.2N	9 27
47	*Port Gentil* (*Cape Lopez*)	" 7–8	0 42.6S	8 46
	Belgian Congo			
48	*Boma*	" 20–22	5 51.5S	13 04
49	Chinquengue	Nov. 7	5 52 S	13 08
	French Equatorial Africa			
50	*Brazzaville*	" 18	4 17.0S	15 17
51	Boukiero	" 22	4 11.5S	15 18
	Belgian Congo			
52	*Bolobo, B*	" 27–29	2 09.6S	16 17
53	Bolobo, *C*	Dec. 4	2 09.6S	16 17
	French Equatorial Africa			
54	Bangui	" 26– Jan. 13, 1917	4 21.5N	18 35
		1917		
55	Kana	Jan. 21	4 29	18 29
56	Djoumba	" 23	4 40.4N	18 34
57	Damara	" 25	4 58.0N	18 42
58	Diouma	" 28–29	5 21.0N	18 43
59	Bi River	" 30–31	5 38.4N	18 51
60	Fort Sibut	Feb. 2–4	5 43.0N	19 06
61	La Bassinda	" 12	5 59.7N	19 10
62	Dekoa	" 14–16	6 18.5N	19 08
63	Iki	" 18	6 41.5N	19 07
64	Fort Crampel	" 21	6 59.0N	19 12
65	Second Encampment North of Fort Crampel	" 25	7 30.2N	19 03
66	Lito, *A*, *B*	" 27	7 54.0N	19 02
67	Irena	Mar. 2–3	8 34.3N	19 06
68	Moyo Combo	" 5	8 53.6N	18 43
69	Fort Archambault	" 13–15	9 08.9N	18 26

TABLE 30—*Continued.*

No.	Name	Date	Latitude	Long. East
	French Equatorial Africa			
70	Second Encampment	*1917*	° ′	° ′
	North of Fort Archambault.....	Mar. 30–31	9 24.6N	18 10
71	Niom..................	Apr. 1–2	9 47.4N	17 48
72	Miltou.................	" 4–5	10 13.2N	17 28
73	Sixth Encampment			
	North of Fort Archambault.....	" 6	10 29.0N	17 06
74	Bousso.................	" 8	10 28 N	16 43
75	Ninth Encampment			
	North of Fort Archambault.....	" 10–11	10 42.4N	16 16
76	Baleiniere..............	" 12	10 50.0N	15 44
77	Mogroum..............	" 15–16	11 06.8N	15 24
78	Milé..................	" 18	11 43.4N	15 20
79	Fort Lamy, *A*............	" 26–27	12 06.6N	15 02
	Cameroun			
80	Dragh.................	May 2–3	12 16.7N	14 54
	French Equatorial Africa			
81	Mani..................	" 4	12 43.8N	14 41
82	Bol...................	" 8	13 27.4N	14 43
83	Keliganga..............	" 12	13 52.3N	15 04
84	Mao..................	" 16–19	14 07.7N	15 19
85	Goudjour..............	" 30	14 01.9N	15 38
86	N'Galo Billani...........	June 1	13 54.3N	15 49
87	Deuguelba..............	" 3–4	13 46.6N	16 12
88	Am Raya..............	" 9	14 08.1N	16 32
89	Moussou Morra..........	" 13	13 39.1N	16 33
90	Hadjilidié..............	" 18–19	13 22.9N	17 00
91	Diamené..............	" 22	13 06.7N	17 25
92	Abakatal..............	" 24–25	13 06.5N	17 42
93	Djidodo...............	" 28	13 07.6N	18 02
94	Ati..................	July 2	13 12.8N	18 27
95	Roumbou..............	" 5–7	13 29.8N	18 43
96	Abou Tibené............	" 9–10	13 47.6N	19 08
97	Haraze...............	" 12–13	13 57.4N	19 33
98	Affoughly..............	" 16–17	13 50.1N	20 00
99	Mussak...............	" 19	13 47.4N	20 21
100	Abeché...............	" 25–28	13 49 N	20 51
101	Mourra...............	" 31	13 47.8N	21 13
102	Bir Taouil.............	Aug. 4	13 43.4N	21 43
103	Tountouma.............	" 8–9	13 44.5N	22 02
	Anglo-Egyptian Sudan			
104	Djenené...............	" 14–15	13 25.4N	22 24
105	Asserni...............	" 19–20	13 30.8N	22 38
106	Camp August 22..........	" 22	13 32 N	23 06
107	Elga.................	" 24–25	13 29.7N	23 33
108	Kebkebia..............	" 28	13 38.5N	24 01
109	Om..................	" 31	13 39.1N	24 31
110	Shaba................	Sep. 3–5	13 30.7N	24 50
111	El-Fasher..............	" 15–17	13 37.6N	25 21
112	Rahad Sheraf...........	Oct. 5	13 37.1N	25 51
113	Abiat................	" 8	13 45.3N	26 30
114	Um Esheishat...........	" 11	13 33.7N	26 51
115	Jebel Hella.............	" 13–14	13 27.1N	27 08
116	Dam Gamad............	" 16	13 16.6N	27 31
117	Wad Banda.............	" 18	13 05.5N	28 01
118	El Nahud..............	" 25–29	12 40.3N	28 28
119	Markib...............	" 31	12 55.3N	28 54
120	Dudieh...............	Nov. 2	13 06.2N	29 25
121	Nyemeir..............	" 4	13 08.8N	29 50
122	El Obeid..............	" 13–16	13 10.7N	30 14
123	Um Ruaba.............	" 18–21	12 54.4N	31 13
124	Kosti................	" 23–24	13 10.3N	32 40
125	Sennar...............	" 27–28	13 34.2N	33 35
126	Khartum..............	Dec. 9–10	15 36 N	32 33
		1918		
127	El Getaineh............	Jan. 14	14 52 N	32 30
128	El Dueim..............	" 16–17	13 59 N	32 19
129	Renk................	" 23–24	11 45.0N	32 47
130	El Galhak.............	" 26	11 03.3N	32 32
131	Melut................	" 30–Feb. 1	10 26.6N	32 09

TABLE 30—*Concluded.*

No.	Name	Date	Latitude	Long. East
	Anglo-Egyptian Sudan	*1918*	° ′	° ′
132	Kodok	Feb. 3–4	9 53.0N	32 07
133	Malakal	" 6	9 32.1N	31 38
134	Taufikia	" 8	9 25 N	31 37
135	Tongo	" 11	9 28.1N	31 04
	Uganda			
136	Rejaf	" 23–25	4 44.1N	31 38
137	*Gondokoro*	Mar. 6	4 53.9N	31 43
	Anglo-Egyptian Sudan			
138	Mongalla	" 8	5 11.8N	31 48
139	Bor	" 13–14	6 12.4N	31 36
140	Shambe	" 21	7 07 N	30 50
141	Kilometer 285, Bahr el Zeraf	" 27	7 48 N	30 37
142	Golietta	Apr. 13	12 17.7N	32 41
143	Gedaref	" 27	14 02 N	35 24
144	Mogatta	" 29	14 42.5N	35 52
145	Kassala	May 3	15 27 N	36 24
	Eritrea			
146	Agordat	" 9	15 32 N	37 54
147	*Asmara*	" 14–17	15 21.0N	38 56
148	*Massaua*	" 19	15 36.2N	39 27
	Anglo-Egyptian Sudan			
149	*Port Sudan*	" 25	19 37.4N	37 14
150	Sinkat	" 27–28	18 46 N	36 48
151	Musmar	June 3	18 13.1N	35 35
152	Atbara	" 8–9	17 42 N	34 00
153	Shereik	" 15	18 47.0N	33 38
154	Abu Hamed	" 16–17	19 32 N	33 20
155	Station No. 6	" 19	20 45.6N	32 35
156	Wadi Halfa	" 22–23	21 56 N	31 21
	Egypt			
157	Khattara	July 4	24 13 N	32 53
158	Luxor	" 8	25 43 N	32 39
159	*Helwan Observatory, N*	" 12–19	29 51.6N	31 20
160	*Helwan Observatory, H*	" 12–26	29 51.6N	31 20
161	*Suez*	Aug. 28	29 57.9N	32 33
162	*Tor*	Sep. 2	28 14.4N	33 36
	Arabia			
163	*Jidda*	" 6	21 28.3N	39 11
164	*Aden*	" 13	12 47.1N	44 59
	French Somaliland			
165	*Jibuti*	" 22	11 34.2N	43 08
	Abyssinia			
166	*Addis Abeba, Catholic Mission*	Oct. 13	9 01.8N	38 46
	Ceylon			
167	*Colombo, A*	" 29–30	6 54.2N	79 52
	Straits Settlements			
168	*Singapore, Botanical Gardens*	Nov. 8–9	1 18.9N	103 48
169	Singapore, Holland Road	" 12–13	1 16 N	103 48
	Japan			
170	*Sugita*	Dec. 9	35 22.7N	139 38

The number of miles traveled on the entire trip was 41,470, of which 5,000 were by canoe and caravan, 9,490 by railroad, river steamers and automobile, and 26,980 by ocean steamers. The time spent on the complete trip was 3 years and 38 days. An average of 36 miles was covered for each day absent from the Office. Exclusive of the cost of travel to and from the field, the average cost of a station was about $31.

In all parts of the world I have met with the most courteous treatment possible; even in places where I was subject to suspicion by military authorities before proper credentials could be furnished, I was accorded every possible kindness. It is impossible to mention all the authorities and individuals who gave much valuable assistance. The courtesies extended by His Excellency, Stack Pasha, Governor-General of Anglo-Egyptian Sudan; His Excellency, M. Merlin, Governor-General of French Equatorial Africa;

M. Merlet, Lieutenant-Governor of the Tchad Territory; and by M. Thomann, Lieutenant-Governor of Gabon, were of very great assistance to me in the carrying out of the work.

H. R. SCHMITT, ON MAGNETIC WORK IN PERU, CHILE, BOLIVIA, AND BRAZIL, MARCH TO NOVEMBER 1914.

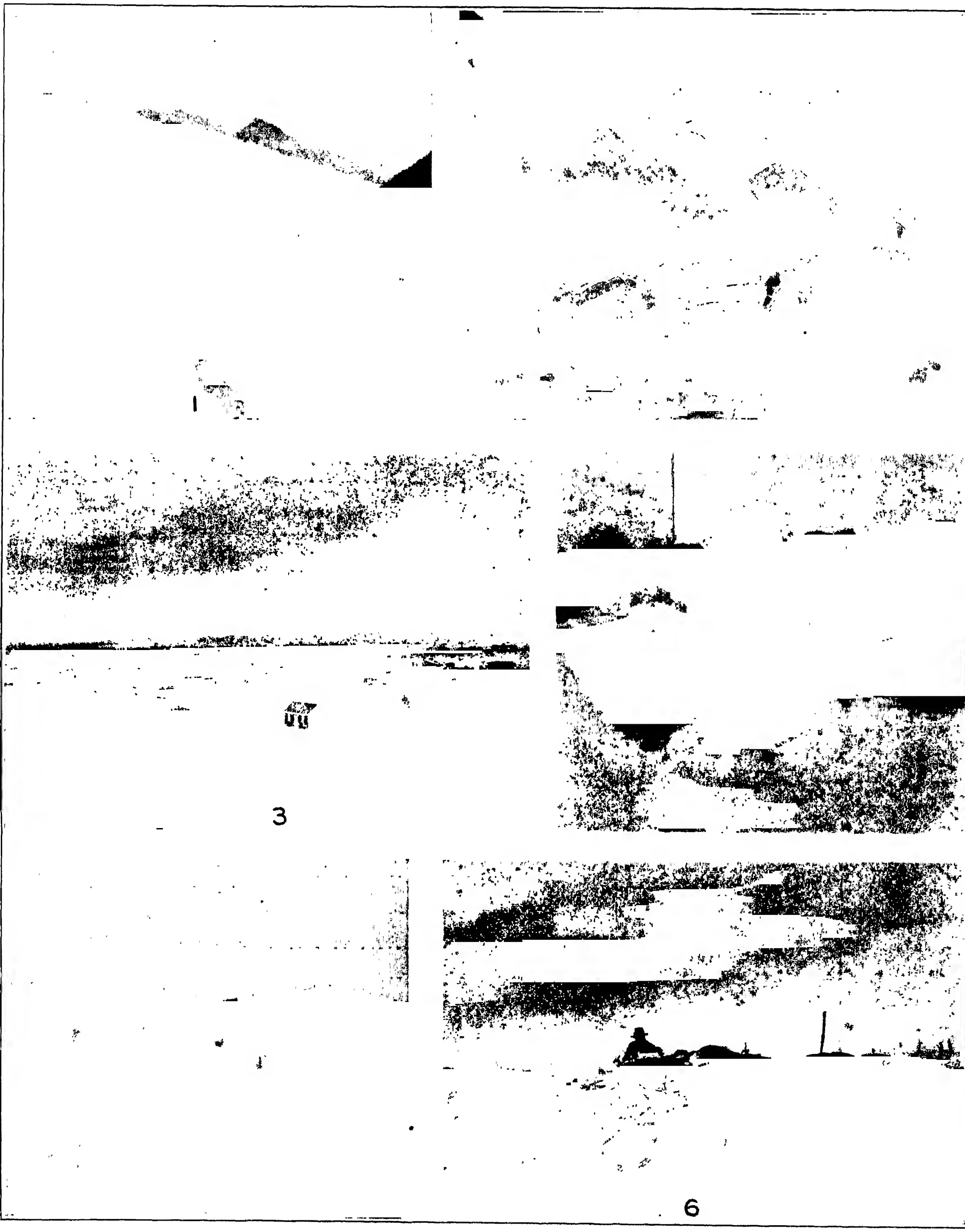
The work was executed in accordance with instructions dated February 26, 1914, and supplementary instructions dated March 4, 1914. I left Washington, D. C., on March 6, and began field work at Lima, Peru, on March 25. Field work ended at Pinheiro, Brazil, on October 29, and I returned to Washington November 27. The instrumental equipment used throughout the trip consisted of universal magnetometer No. 19, a pocket chronometer, 3 watches, and other accessories.

A brief outline of the itinerary followed on this expedition is as follows: After brief stops at Kingston, Jamaica, and Callao, Peru, I reached Arica on April 2, and thence traveled by the new railway by way of La Paz and Oruro to Changolla, Bolivia. From this point the overland trip by coach was made to Cochabamba, whence Puerto Suarez, Bolivia, on the Paraguay River, was reached by mule pack-train, and a 6-mile ride by launch brought us to Corumba, Brazil. Thence I ascended the Paraguay River to São Luiz de Caceres, going by mules overland to Matto Grosso on the Guaporé River. The route next lay down the Guaporé, the Mamoré, and the Madeira Rivers to Manaos on the Amazon. The work was completed by observations at Pinheiro, near Belem, Para.

On the way from New York to Arica, Peru, I occupied the magnetic station at Kingston, Jamaica, established by the United States Coast and Geodetic Survey, and reoccupied the one at Lima and the one on San Lorenzo Island, off Callao. From Arica, Chile, I traveled by the new railway to Changolla, Bolivia, by way of La Paz, and secured as many stations as possible along this line, but as there are no towns along the railway, the country being mostly desert with few inhabitants, I had to spend the night on the bare floor of the small station houses on several occasions and go without food. A supply of food and a camp outfit are necessary if one desires to make many stops along this line of railway. After going by rail from La Paz to Changolla by way of Oruro, the railway was left and the journey to Cochabamba was made by coach.

Preparations were made at Cochabamba for the trip to Puerto Suarez. In addition to provisions and camp equipment purchased in Cochabamba, I obtained good mules to be used to Santa Cruz. The first part of the journey, Cochabamba to Santa Cruz, was made in 15 days, including the time spent in establishing 4 stations. The trail on this part of the trip, though fairly well constructed, has many very steep ascents and descents to be made every day in getting over the eastern Andean mountain ranges. A station was established at Santa Cruz and mules hired for the next part of the journey, Santa Cruz to Puerto Suarez, which began on May 25 and ended with arrival at Puerto Suarez on June 20, a total of 27 days being consumed in traveling and establishing 8 stations. The trail was found to be always a broad one, and in the height of the dry season it was in good traveling condition with the exception of a number of short stretches. In the dry season, however, there is much inconvenience due to lack of drinking water, and precautions against surprise and attack by the Indians are then also necessary. It is advisable to carry a rifle within convenient reach and where it can be seen by the Indians.

A launch was taken for the 6-mile trip from Puerto Suarez, Brazil, to Corumba, Brazil, where the C. I. W. station was reoccupied and arrangements made for the trip to São Luiz de Caceres. Prices in Corumba and Matto Grosso are much higher than in Bolivia, with wages for labor correspondingly high, and as a consequence travel in this region is very expensive. After consulting those who had made the trip, it seemed to be



TYPICAL VIEWS OF MAGNETIC EXPEDITIONS IN SOUTH AMERICA.

1. View on road to Bogota, Colombia.
2. Andes village, Colombia.
3. Punta Arenas, Chile.
4. Maraba, Brazil.
5. Llama pack-train near Tirapata, Peru.
6. Transportation, Punta Arenas to Ultima Esperanza, Chile.

generally conceded that to go from Corumba to Guayara Mirim would cost about $2,000, which would include the hire of a launch up the Paraguay River to São Luiz de Caceres, the cost of the overland journey by mule train to Matto Grosso, and finally the purchase of a boat with the wages and subsistence of the necessary crew for the trip down the Guaporé and Mamoré rivers. The regular boat up the Paraguay River runs only at long intervals, and, as the current is too strong for a canoe, it is necessary to hire a launch. After some delay in trying to obtain one at reasonable terms, a launch was finally chartered, on which I left Corumba July 4 and arrived at São Luiz de Caceres July 9, where arrangements were made for the overland trip to Matto Grosso. A delay of over a week was occasioned in trying to hire mules. Those finally secured were in such poor condition that they took 4 days longer than should have been necessary.

Having arrived at Matto Grosso on July 28, I immediately began preparations for the long river journey to Guayara Mirim by way of the Guaporé River which for a long distance forms the boundary between Brazil and Bolivia. There are no launches by which to make this trip, and boats can not be hired on account of the great distance. It is, therefore, necessary to buy a boat, and I was advised that a fairly large boat was desirable on account of the sudden winds that sometimes arise on this large river. As the proposed route was down-stream, a large crew was not required, and 2 Indians, beside myself and an assistant who had been engaged to accompany me from La Paz to Manaos, were sufficient.

I bought the boat, and on July 30 we began paddling the 1,200 miles to Guayara Mirim, where we arrived on September 13. With the exception of the rapids at the Forte Principe do Beira, the river was easily navigable throughout the length traversed. In the upper and lower stretches the ordinary precautions against surprise and attack by the Indians are necessary. During the 45 days required to make this journey from Matto Grosso to Guayara Mirim, 11 stations were established. We paddled at an estimated rate of about 3 miles per hour usually for about 10 or 12 hours each day, though sometimes for much longer, making as high as 60 or even 65 miles in one day. Since villages or trading settlements are not numerous, the stations were established at suitable intervals as desirable places were found. These stations are, therefore, referred to by number. From Guayara Mirim we traveled over the Madeira-Mamoré Railroad to Porto Velho, where a launch was hired for the trip down the Madeira River to Manaos. We left Porto Velho on September 23 and arrived at Manaos October 16, having been delayed somewhat through the necessity of stopping each day in order to chop wood for fuel for the launch.

After concluding the work at Manaos, I proceeded down the Amazon by steamer to Para, where opportunity was afforded during a delay caused by war conditions to reoccupy the secular-variation station at Pinheiro. I arrived at Bridgetown, Barbados, November 9, and took passage on the same day for New York, no time being available for reoccupation of the magnetic station.

The total time occupied in the establishment of the 57 stations from my departure to my arrival in Washington was 260 days, with an average field time per station of about 4 days. The total distance traveled was about 12,600 miles, of which about 7,810 miles was travel to and from the field, leaving 4,790 miles travel in the field. The average field travel is accordingly 84 miles to the station. The average field expense for each of the 57 stations was about $85.

The magnetic conditions encountered were generally good, but it would seem that the region about the 200-mile stretch of the rapids of the Madeira River and the rapids at the Forte Principe do Beira on the Guaporé River is somewhat disturbed, due to the volcanic rock which underlies this whole region and crops out at the various rapids.

Table 31 gives the names of stations occupied, together with dates and geographic positions; the magnetic data will be found in Table of Results.

TABLE 31.

No.	Name[1]	Date	Latitude	Long. East
		1914	° ′	° ′
1	*Kingston*	Mar. 12	17 58.9N	283 11
2	*Lima, Hipodromo*	" 25–29	12 04.3S	282 58
3	*San Lorenzo Island*	" 27	12 05.4S	282 47
4	*Mollendo*	Apr. 1	17 01.8S	287 59
5	*Arica*	" 3	18 28.6S	289 40
6	Estacion Central	" 5	18 22.6S	290 03
7	Puquios	" 7	18 11.0S	290 20
8	Corocoro	" 11	17 13.4S	291 29
9	*La Paz*	" 15–19	16 30.8S	291 49
10	Oruro	" 26	17 59.1S	292 53
11	Cochabamba	May 2–3	17 24.2S	293 40
12	Vacas	" 7	17 34.8S	294 10
13	Totora	" 9	17 44.7S	294 30
14	Puquina	" 13–14	18 02.6S	295 14
15	Samaipata	" 17	18 10.9S	295 28
16	Santa Cruz	" 23	17 47.2S	296 26
17	Rio Grande	" 26	17 40.4S	296 51
18	Tres Cruces	" 28–29	17 35.8S	297 25
19	Motacusito	June 1–2	17 34.6S	298 14
20	San José	" 6	17 50.8S	299 01
21	Ipias	" 9	18 02.9S	299 37
22	Santiago	" 12	18 20.7S	300 04
23	Tucabaca	" 15–16	18 36.2S	300 56
24	Yacuses	" 18–19	18 58.7S	301 42
25	*Corumba*	" 26	18 59.4S	302 21
26	Porto Baguary	July 5	18 25.5S	302 36
27	Lake Gaiba	" 6	17 44.3S	302 20
28	Porto Concepcion	" 7	17 08.8S	302 37
29	Porto Curichão	" 8	16 37.0S	302 07
30	São Luiz de Caceres	" 9–14	16 04.1S	302 17
31	Fumasa	" 20	15 58.0S	301 39
32	Asareas	" 23	15 37.5S	301 38
33	Pontes e Lacerdas	" 26	15 13.3S	300 36
34	Matto Grosso	" 29	15 00.6S	300 00
35	Guaporé 1	Aug. 1–2	14 32.6S	299 52
36	Guaporé 2	" 5	14 01.8S	299 37
37	Guaporé 3	" 8	13 44.9S	299 22
38	Guaporé 4	" 11	13 29.7S	298 56
39	Guaporé 5	" 16–17	13 33.8S	298 31
40	Guaporé 6	" 22	13 21.8S	298 00
41	Guaporé 7	" 27	13 01.2S	297 14
42	Guaporé 8	" 31–Sep. 1	12 30.6S	296 25
43	Guaporé 9	" 5	12 23.9S	295 31
44	Guaporé 10	" 6	12 13.3S	295 26
45	Mamoré 11	" 10	11 40.3S	294 46
46	*Guayara Mirim*	" 15	10 48.0S	294 37
47	*Porto Velho*	" 19	8 45.6S	296 05
48	Pombal	" 26	8 31.1S	296 37
49	Humayta	" 28	7 30.3S	296 51
50	Bom Futuro	Oct. 1–2	6 15.1S	297 40
51	Boca de Capana	" 4	5 51.6S	298 14
52	Incante	" 6	5 34.1S	298 51
53	Vista Alegre	" 8–9	4 53.9S	299 56
54	Perseverança	" 11	4 05.2S	300 38
55	São Juaquim	" 13	3 31.6S	301 04
56	*Manaos, I*	" 19	3 08.5S	300 00
57	*Pinheiro, A*	" 29	1 17.9S	311 31

[1] The stations are in the following countries: No. 1, Jamaica; Nos. 2 to 4, Peru; Nos. 5 to 7, Chile; Nos. 8 to 24, 37, 39, 41, 45, and 46, Bolivia; Nos. 25 to 36, 38, 40, 42 to 44, and 47 to 57, Brazil.

A. STERLING, ON MAGNETIC WORK IN CHILE, BOLIVIA, BRAZIL, AND THE GUIANAS, FEBRUARY 1917 TO JULY 1918.

According to instructions of September 16, 1916, from the Director, I was detached from the party under Mr. D. M. Wise, after 4 months of instruction and practice, to undertake independent work. My instrumental equipment consisted of universal magnetometer No. 21, a pocket chronometer and three watches, observing tent, and the usual accessories. The universal magnetometer was originally supplied with needles 1 and 3 of magnetometer No. 19, and 5 and 6 of magnetometer No. 20. Needles 1 of 19 and 5 of 20 became so unreliable that they were replaced in June 1917 at La Paz by 1 and 2 of magnetometer No. 21.

I left Mr. Wise at Mollendo, Peru, February 5, 1917, and arrived the following day at Arica, the most northerly port of any considerable size in Chile. After reoccupying the C. I. W. station at Arica, I proceeded by sea to Iquique, arriving February 10. Plans were changed slightly now to take advantage of the continuous railroad connection from Iquique south to the more thickly populated part of Chile. This was especially desirable, in view of the fact that so many vessels had been taken off the west coast for war purposes, while the German vessels were tied up, leaving steamer service considerably below normal. From Iquique I continued by train and by steamer to Coronel, Chile, occupying 15 stations en route of which 4 were reoccupations of former stations; 2 stations were reoccupied at Coronel, the relocation of one being close and the other exact.

From Coronel I traveled to Uyuni, Bolivia, making reoccupations en route of my own stations at Santiago and Antofagasta for additional longitude data, as well as additional magnetic data. My ascent from Antofagasta, at sea-level, to Uyuni, 12,000 feet, was too rapid, and I suffered an attack of soroche, or mountain sickness, so severe that I gave up the proposed trip to Tupiza and proceeded to La Paz, arriving May 28. Correspondence and computing were brought to date here, a station was occupied, control observations were made for replacing two dip needles, and plans were completed for entering another phase of my trip—travel in the jungle.

On July 4 I went by automobile to Achacache, on the shore of Lake Titicaca, and from there to Sorata on mule-back. After occupying a station at Sorata, and adding to my supplies and camping equipment, I started over the divide on July 17 with a train of 7 mules, 2 of which were saddled for riding. Two Indians drove the mules, and a Bolivian boy, Luis F. Manzaneda, acted as helper and guide, and translated the language of the Aymara Indians into Spanish. The trail was so rough that it was much easier and faster to walk and let the saddle mule stay with the pack train. The descent from the divide, at 16,500 feet, into the jungle, was rapid, and the snow was only a day's travel from orange, lemon, and banana trees.

We arrived July 25 at Guanay, on the headwaters of the Beni River, an affluent of the Madeira, which in turn flows into the Amazon, and were obliged to remain there a week while the Indians, who otherwise would have guided our raft, stopped to help in the building of a church. After attending the dedication ceremonies, we left Guanay on a well-designed, well-constructed, and well-manned native raft, called a callapo. From Guanay to Rurrenabaque, the head of steam-launch navigation during the wet season, is the most dangerous part of the river. We arrived August 4, a national holiday, when observations were postponed on account of the celebration.

After further plans were made at Rurrenabaque, I left August 20 on another callapo with 3 Indians, having been delayed several days, first by their celebrations, then by their refusing to start on Friday, and finally by losing a raft and having to construct a new one. A Spaniard, Luis Arroyo, took Manzaneda's place as cook and general helper. The population of Rurrenabaque came to the river and bade us farewell, saluting

with their 44-calibre Winchester rifles. We drifted a month on the river, stopping only to occupy stations en route, and occasionally for an hour's hunt for monkeys, turkeys, or pigs, which added materially to the variety and quantity of our menu. I had arranged that the Indians furnish their own food, but they adhered to their custom of leaving the responsibility of food supply with the chief of the party and I was obliged to supply almost all their provisions for the voyage.

We arrived at Riberalta on September 23 intending, if possible, to ascend the Madre de Dios River, but found that all the boats were waiting for the wet season, as that river was at the time almost dry. I therefore continued down the Beni River to Villa Bella, at the mouth of the Mamoré River, and from there by train to Guayara Mirim. It was at this point that I suffered the only really serious sickness of the whole trip. Upon partial recovery, I gave up my original plan to ascend the Mamoré to Trinidad, and proceeded down the Madeira River by the Madeira–Mamoré Railroad to Porto Velho in Brazil.

From Porto Velho I went by a good river steamer to Manaos, where I arrived October 29, 1917, and received my first mail since June. After bringing everything up to date, I arranged to ascend the Purus River by taking passage from place to place whenever the unscheduled but frequent steamers came along. The plan was entirely successful, and I went up the Acre River, an affluent of the upper Purus, to Xapuri, a point quite close to the Bolivian border, establishing 8 stations en route. I returned to Manaos and thence proceeded to Obidos and Santarem, reoccupying stations at each place. From Santarem I went up the Tapajoz River for a 10 days' trip by motor-canoe above the head of steam navigation, arriving March 8 at the confluence of the São Manoel and Juruena rivers. I made observations here and at 3 other points above Santarem, but was unable to stop at another point as originally planned on account of the very serious illness of one of the men on the boat. The boats on which this trip was made carry about 10 tons of cargo, a crew of 12 or more very skilful boatmen, and from 1 to 5 or 6 passengers. In stretches where the current was swiftest, we went close to shore. The gasoline motor working full speed was helped by 12 husky natives, the owner of the boat, and the magnetic observer aboard, all pushing and pulling with poles arranged with various kinds of hooks, prongs, and points adapted for grappling branches, vines, and stones, or for poling. At times a rope was laboriously carried from tree to tree by which the boat was pulled through the rapids. The work was very strenuous, and on a few occasions a stretch of perhaps 50 feet was passed in no less than a half day, while clothes were literally torn from our backs.

From Santarem I went to Belem, Para, occupying one station en route. No practicable route for further work in the region of the mouth of the Amazon was open at that time, and after reoccupying the secular-variation station at Pinheiro, and making a short trip by rail to Bragança, I proceeded to the Guianas and reoccupied C. I. W. stations at Cayenne, French Guiana; Paramaribo, Dutch Guiana; Georgetown and New Amsterdam, British Guiana.

At Georgetown I received a cablegram to return to Washington by the safest route. I accordingly left Georgetown June 27, 1918, for St. Thomas, Virgin Islands, and caught a Swedish steamer for New York. I arrived July 8, 1918, and reported at Washington the following day.

Table 32 (see p. 199) gives a list of the stations occupied, with dates and geographic positions; for magnetic data, see Table of Results.

The time from sailing from New York to my arrival at New York was over 21 months, but a part of this time was spent on my instruction trip (see report by Observer D. M. Wise). The actual field time was 16½ months, which gives an average of about 8 days field time per station. During much of the trip rapid travel was impossible, and

TABLE 32.

No.	Name[1]	Date	Latitude	Long. East
		1917	° ′	° ′
1	*Arica*	Feb. 7	18 28.6S	289 40
2	*Iquique*	" 10	20 12.7S	289 50
3	Pisagua	" 14–15	19 35.0S	289 49
4	Pintados	" 21	20 37.7S	290 24
5	Tocopilla	" 25	22 05.2S	289 48
6	Toco	" 27	22 04.5S	290 24
7	*Antofagasta*	Mar. 3	23 38.8S	289 38
8	Catalina	" 11–12	25 14.6S	290 20
9	Taltal	" 14–15	25 23.6S	289 35
10	Chanaral	" 17	26 20.4S	289 27
11	Caldera	" 23	27 04.0S	289 14
12	Copiapo	" 25	27 22.0S	289 43
13	Vallenar	" 27	28 34.9S	289 18
14	*Huasco*	" 30–Apr. 1	28 27.2S	288 51
15	Coquimbo	Apr. 6	29 57.8S	288 40
16	*Valparaiso*	" 14	33 04.4S	288 25
17	*Santiago, A*	" 18, May 5	33 26.7S	289 18
18	*Coronel, A, C*	" 25, 29–30	37 01.9S	286 51
19	*Antofagasta*	May 16–17	23 38.8S	289 38
20	*Uyuni*	" 23	20 28.0S	293 11
21	*La Paz*	June 4–11	16 30.8S	291 47
22	Sorata	July 7, 9, 14–15	15 46.3S	299 12
23	Guanay	" 27–28	15 30.1S	291 55
24	Rurrenabaque	Aug. 5, 7, 10	14 26.5S	292 19
25	Tarene	" 25	13 47.6S	292 23
26	Muque	" 31	13 10.5S	292 40
27	San Luis	Sep. 6–8	12 32.3S	293 00
28	Copacabana	" 15–16	11 32.2S	293 14
29	Riberalta	" 28	11 00.0S	293 55
30	*Guayara Mirim*	Oct. 10	10 48.0S	294 37
31	*Abuna*	" 15	9 42 S	294 37
32	*Porto Velho*	" 21–22	8 45.6S	296 05
33	*Manaos, I*	Nov. 6, 8	3 08.5S	300 00
34	Bocca do Purus	" 22	3 39.9S	298 35
35	Guajaratuba	" 27–28, Dec. 1	5 00.6S	297 04
36	Aruma	Dec. 3	4 43.8S	297 54
37	Nova Olinda	" 10	5 34.5S	295 40
38	Allianca	" 12–13	6 33.5S	295 36
39	Labrea	" 19–21	7 15.4S	295 10
40	Hyutanahan	" 24	7 39.6S	294 13
41	Bocca do Pauhiny	" 30	7 47.2S	292 55
		1918		
42	Xapury	Jan. 9–10	10 38.9S	291 27
43	Empreza	" 15–17	9 58.5S	292 12
44	Bocca do Acre	" 20	8 45.5S	292 36
45	*Manaos, I*	Feb. 2	3 08.5S	300 00
46	*Obidos*	" 12	1 55.8S	304 32
47	*Santarem*	" 16–17	2 24.9S	305 21
48	San Luiz	" 22, Mar. 16–17	4 27.2S	303 50
49	Barro do São Manoel	Mar. 9	7 20.5S	301 56
50	Villa Nova	" 12	6 33.3S	301 43
51	Urucurituba	" 20	3 48.2S	304 25
52	Almeirim	Apr. 5	1 32.0S	307 26
53	*Pinheiro, A*	" 12–May 10	1 17.9S	311 31
54	Castanhal	" 26	1 17.9S	312 05
55	Bragança	May 1	1 03.7S	313 14
56	Timboteua	" 2–3	1 12.4S	312 36
57	*Cayenne*	" 21–23, 26	4 56.1N	307 40
58	*Georgetown*	June 2, 22	6 48.6N	301 51
59	*Paramaribo*	" 11, 13, 17	5 50.0N	304 51
60	*New Amsterdam*	" 20	6 16.3N	302 29

[1] The stations are in the following countries: Nos. 1 to 19, Chile; Nos. 20 to 30, Bolivia; Nos. 31 to 56, Brazil; Nos. 57 to 60, Guianas.

at other times its cost would have been out of all proportion to its advantages. The total distance traveled from the time I left Mr. Wise at Mollendo was about 14,700 miles, of which about 4,200 miles was by ocean steamer, 6,000 miles by river steamer, 2,500 miles by train, and the remaining 2,000 miles by raft, canoe, walking, and riding. This total gives an average of 253 miles per station. The average field expense was slightly over $65 per station.

A. STERLING, ON MAGNETIC WORK IN CHILE AND ARGENTINA, FEBRUARY TO OCTOBER 1919.

In accordance with the instructions dated February 15, 1919, I left Washington February 18, 1919, and sailed from New York February 25 on the steamship *Ortega*, in company with Dr. Edmonds, who was going to establish the Department's magnetic observatory in Peru. My instrumental equipment consisted of theodolite-magnetometer No. 16, dip circle No. 242 (with dip needles 1, 2, 5, and 6, and intensity needles 3 and 4 for emergency use as dip needles), tripod, observing tent, one pocket chronometer, 3 watches, camera, tape, pocket compass, instrument trunk-cases, and other accessories.

Soon after my arrival at Valparaiso in March 1919, it became apparent that in view of the advancing season it would be best to proceed south to Punta Arenas and thence work northward in Patagonia, rather than to proceed south from Valparaiso as originally planned. Accordingly, after reoccupying Department stations at Santiago and Puerto Montt, I sailed south March 30 through the inland channels of southern Chile. The trip was interesting and very scenic, but heavy clouds and rain generally obstructed the view and made good photographs impossible.

The 1913 station of the Argentine Meteorological Service at Punta Arenas was occupied, and a side trip by automobile was made to Ultima Esperanza, about 175 miles northwest, on the Chilean side of the border (see views 3 and 6 of Plate 6). Returning to Punta Arenas, after some difficulty I was able to arrange for transportation by automobile to Gallegos, Argentina, a point on the Atlantic side very nearly due east of Ultima Esperanza. In this way I was able to secure a much better distribution than I could make by depending on water transportation. It was a pleasant surprise to find the roads of this part of Patagonia so well adapted to automobile travel. As local conditions did not permit making an excursion inland at Gallegos, I again made use of the automobile as far north as Santa Cruz whence I went to San Julian by steamer, arriving April 28.

A plateau sharply divides the climatic zones between Gallegos and Santa Cruz. Fortunately, work was completed in the severe Gallegos region and the plateau was crossed before the snows fell. There are fair roads for automobiles on the Santa Cruz side, when dry, but unprecedented rains precluded any trips and held me at San Julian until I finally left on the steamer for Puerto Deseado and arrived May 25.

At Puerto Deseado, I secured the permits and made other requisite arrangements for observations during the total solar eclipse of May 29. By June 5, having finished, computed, and mailed the eclipse observations, I went by rail to Las Heras, and thence about 100 miles to Kilometro 163 of the Comodoro Rivadavia Railway by automobile, occupying stations at Las Heras, Las Mesetas, and Kilometro 163. Arriving at Comodoro Rivadavia June 13, I reoccupied the Argentine Meteorological Office station of 1913, and on June 16 caught the steamer for Puerto Madryn. Stations were occupied at Madryn and Dolavon, after which I proceeded to Buenos Aires by sea, arriving July 4.

After cable correspondence with the Office at Washington, definite plans were made for the remainder of my trip. These contemplated a series of trips by rail and automobile to parts of Argentina, generally south and southwest of Buenos Aires, for the purpose of extending the series of reoccupations, for secular variation, of stations of the Argentine Meteorological Office which had been made by members of the *Carnegie* party in 1917.

It was also desired to connect that series with the present work by again reoccupying a number of their stations. After carrying out these plans, and after reoccupying the station at Colon, Uruguay, I proceeded to Brazil and made intercomparisons with standard instruments of the National Magnetic Observatory at Vassouras, near Rio de Janeiro.

After completing work at Vassouras, I secured passage on the *Vasari*, sailing from Rio de Janeiro October 8 to Hampton Roads, and reported at Washington October 28.

Table 33 gives list of stations occupied, with dates and geographic positions; for magnetic data, see Table of Results.

TABLE 33.

No.	Name[1]	Date	Lat. South		Long. East	
		1919	°	′	°	′
1	*Santiago, A*	Mar. 24	33	26.7	289	18
2	*Puerto Montt*	" 28–29	41	29.3	287	04
3	Punta Arenas[2]	Apr. 8, 14–17	53	10.4	289	08
4	Ultima Esperanza	" 10	51	41.1	287	31
5	Rio Gallegos[2]	" 22	51	36.5	290	50
6	Santa Cruz[2]	" 26	50	00.9	291	30
7	San Julian	May 1, 3	49	15.1	292	22
8	Mata Grande	" 18, 20	48	50.8	292	27
9	Puerto Deseado[2]	" 28–June 1	47	44.6	294	05
10	Colonia Las Heras	June 6	46	43	291	09
11	Las Mesetas	" 8–9	46	13	290	27
12	Parada Kilometro 163	" 11	45	47.3	291	14
13	Comodoro Rivadavia[2]	" 15	45	51.0	292	31
14	Puerto Madryn[2]	" 20	42	45.8	294	58
15	Dolavon	" 23–24	43	18.1	294	17
16	*Mercedes*[2]	July 25, Sep. 2–3	34	40.3	300	33
17	*Bahia Blanca*[2]	" 31	38	46.7	297	44
18	*Zapala*[2]	Aug. 4	38	55.2	289	56
19	*Cipolletti*[2]	" 6–8	38	56.3	292	00
20	Patagones[2]	" 15	40	47.7	297	01
21	Huahuel Niyeu	" 20	41	19.4	290	28
22	Valcheta[2]	" 22	40	41	293	51
23	San Antonio[2]	" 24	40	43.5	295	06
24	*Colon*	Sep. 9	34	48.3	303	46
25	*Vassouras, A, B, C, E, F, G*	" 23–26	22	24.0	316	21

[1] The stations are in the following countries: Nos. 1 to 4, Chile; Nos. 5 to 23, Argentina; No. 24, Uruguay; No. 25, Brazil.

[2] Point previously occupied here by the Argentine Meteorological Office.

The time between sailing from New York and arrival at Norfolk, Virginia, was 8 months. The field time counted from arrival at Valparaiso, Chile, to sailing from Rio de Janeiro, Brazil, was about 6½ months, which gives an average of about 8 days per station, field time, including intercomparisons at Vassouras, Brazil. The total distance traveled was about 19,000 miles, of which about 13,500 was by steamer, 4,000 by train, and 1,500 by automobile. The expense, including passage to the field and return, was about $120 for each station.

In general, Patagonia is not subject to great local magnetic disturbances, but the soil everywhere is somewhat magnetic.

Valuable assistance was rendered by the Argentine Meteorological Office, the Brazilian Observatory officials, also by Mr. Frank Potter of San Julian, Argentina, and Mr. Charles of Las Mesetas, Argentina. Throughout the whole trip government officials and private individuals as well were ready with such aid as they could give to promote the success of the work.

W. F. WALLIS, ON MAGNETIC WORK IN ABYSSINIA, AND ALONG THE MEDITERRANEAN AND RED SEA COASTS, AFRICA, OCTOBER 1913 TO DECEMBER 1914.

The Department's work in Italy and North Africa was executed under instructions dated October 9, 1913, and March 18, 1914, with the following instrumental outfit: theodolite-magnetometer No. 10; dip circle No. 202; marine chronometer; pocket chronometer; 3 watches; aneroid barometer; and observing tent.

I left Washington on October 17, 1913, and sailed from New York the following morning, landing at Naples on October 31. In Rome I called on Professor Luigi Palazzo, Director of the Bureau of Meteorology and Geodynamics, and obtained his cooperation and advice in regard to our proposed work. After reoccupying the magnetic station at Monte Mario, near Rome, I spent a week at Terracina, comparing the Department's instruments with Professor Palazzo's. We then returned to Rome.

The necessary passport for entrance into the colony of Libya was obtained from the Minister of Colonies through the assistance of the American Ambassador at Rome, the Hon. Thomas Nelson Page. His Excellency, the Minister of Colonies, also kindly gave me letters of introduction to the governors of Tripolitania and Cyrenaica.

On the way to Tripoli, a magnetic station was established at Messina, which Professor Rizzo, Director of the Meteorological Observatory, kindly assisted in selecting. The site he had chosen for a magnetic observatory among the hills about 5 miles from Messina, was later visited at his invitation.

Reaching Tripoli on December 15, I met the American Consul, Mr. John Q. Wood, who presented me to the Governor of Tripolitania. The Governor advised against any present work inland in Tripolitania on account of military activities, and on his advice plans were made for a journey eastward to Alexandria on vessels that make weekly calls at various points along the coast. He also very kindly gave me letters of introduction to the officers commanding the garrisons at the points where I proposed to land. Through these letters and similar ones from the Governor of Cyrenaica, I was everywhere accorded the most courteous and hospitable treatment by Italian army officers.

Before leaving Tripoli, I reoccupied the station of 1905 established by Professor Palazzo, and at his request made observations at the Oasis of Tajura on the site chosen for a magnetic observatory for the Italian government. From Tobruk, the last station in Cyrenaica, it was necessary to sail directly to Alexandria, as a large band of hostile Arabs encamped on the way made it impossible to travel through by camel along the Egyptian coast.

After reoccupying the magnetic station near Alexandria, I went to Helwan and spent 3 days at the Khedivial Observatory comparing my instruments with those of the Egyptian government, and thence to Cairo where I obtained from government officials suggestions and advice regarding travel along the north coast of Egypt and general information regarding the status of the magnetic survey of Egypt.

Returning to Alexandria, I began making preparations for a journey westward along the coast to Sellum. The Director of Coast Guards on the north coast gave me valuable assistance in these preparations and, by notifying the commanders at the Coast Guard stations of my coming, secured for me the greatest hospitality and assistance on my arrival. I left Alexandria on April 10 by rail for the terminus about 145 miles west. The journey from the rail terminus to Sellum was made with 3 camel-drivers and 7 camels. The first 2 days were rendered rather unpleasant by a cold northwest wind blowing in our faces, and we finally entered Matruh in a blinding sandstorm, where I was cordially greeted by the Coast Guard officer. Three days were spent at Matruh, making observations and obtaining chronometer corrections from Cairo by telegraph. Our caravan again moved for 2 days through desert country to Negeiyila, a small native

town; 2 more days of travel brought us to Barrani, another Coast Guard station. From Barrani, a journey of 2½ days brought us to Sellum, where the camels and drivers were dismissed. After completing my observations at Sellum, I was enabled, through the courtesy of the Director of Coast Guards, to return to Alexandria with my interpreter and baggage on a Coast Guard cruiser.

On arriving at Alexandria, I received instructions from the Office to proceed to Abyssinia by way of the Red Sea, and to occupy several secular-variation stations on the way. Accordingly, I went to Suez by rail, thence to Port Sudan and Aden by steamer, and finally to Jibuti, on the French Somali coast. A railroad, known as the Franco–Ethiopian Railway, is now being constructed by the French government from Jibuti to Addis Abeba. At the time of my journey, it was completed and opened to traffic as far as Hawash, about 345 miles from Jibuti, leaving about 155 miles still to be completed before reaching Addis Abeba.

At Hawash I engaged as interpreter a Somali who could speak English and Abyssinian and could also cook. I then endeavored to organize a caravan to convey me to Addis Abeba. The rainy season had now begun and camels were no longer used for long journeys; consequently, there was an increased demand for mules, making it impossible to get any on satisfactory terms. I telephoned to the American Consul-General at Addis Abeba and requested him to send mules to meet me at the end of the railway. Mr. Wood informed me that he was leaving Abyssinia, and was starting the very next day. We arranged to meet at Ula Ula, the railway terminus, where his mules would be placed at my disposal. Permission was obtained from the railway company to go 50 miles farther on the construction train.

Accordingly, I left Hawash with my interpreter and baggage on an open freight car that was loaded with steel rails. About 8 hours later, we camped at Ula Ula, and made observations during the 2 days' wait for the Consul-General, who arrived in due time, pitched his camp near mine, and gave me letters of introduction to officials at Addis Abeba. Rain occurred during every one of the 5 days of mule travel from Ula Ula to Addis Abeba. The trail was muddy, and the whole distance was a climb from 3,759 to 8,242 feet, according to the aneroid. The country traversed was a peaceful farming district. The soil was black and fertile, and produced abundant crops even with the very primitive methods of agriculture practiced. The natives were very polite, and were glad to sell us chickens, eggs, and barley bread.

After arriving at Addis Abeba, I paid off and dismissed the caravan, and called at the British and Italian legations. In the absence of the American Consul, the British representative was in charge of American interests, so I arranged with him to secure for me the necessary passport from the Abyssinian government.

In investigating the possibilities of routes to follow to secure a desirable distribution of stations in Abyssinia, I found that the heavy rains at that season, the thick mud, swamps and swollen rivers, left only one other possible route besides the way I had come. This was a route along the mountain tops northeastward to Ankoba and then northward to Asmara. I was warned that the journey would be difficult, and that it would take 2 months, whereas in the dry season it would take but one; nevertheless, I determined to undertake it.

When all preparations were completed, I left Addis Abeba on the morning of July 27 with a caravan of 12 mules and 7 natives; 2 rifles were taken for protection. The 3 weeks' journey from Addis Abeba to Dessié was the hardest part of the trip. It rained incessantly. The mountain trails were steep and rocky, and many streams were difficult to ford. Thick mud and marshes often made traveling very slow. The weather was cold because of the great altitudes. We were frequently above 11,000 feet and but once below 9,000. The country was exceedingly picturesque, great mountains, tre-

mendous gorges, and stupendous precipices giving variety and interest to every mile of the journey. We were well treated along the way by the natives, who often brought us presents of food for men and mules. They live for the most part by agriculture and stock-raising.

Dessié is a rather important town because it is the residence of King Mikael, father of the present emperor, Lij Yasu, whom Menelik appointed as his successor before he died. Among the letters provided me by the kindness of the officials at Addis Abeba was a letter of introduction to King Mikael, and another to Kentiba Gebrou, a chief at Dessié, who speaks English. I first called on Chief Kentiba, an elderly man, who later brought the King's invitation to take breakfast with him and his chiefs the following Sunday morning. The invitation was accepted, and the experience was very unique and interesting.

From Dessié to Makalle, traveling improved; view 6 of Plate 3 is typical of the country traversed. Rains gradually abated, altitudes decreased, and the trails became easier. This part of the journey lasted 18 days. At Makalle I sent my passports with my salutations to Prince Sayum, whose home was there, and received in return a present of sheep, bread, and native beer. The next morning I went to call on the Prince accompanied by an Italian army officer, who with two Greek shopkeepers constituted the European population of the place. I left presents which were apparently acceptable, as that afternoon he sent a yearling heifer with more bread and beer. We left Makalle on September 17 with the good wishes of all.

By this time the rains had entirely ceased, and traveling on that account was much more agreeable. But the scarcity of water now became serious. There had been a stream in every valley and ravine during the rainy season, but now all were dry and we were often compelled to make long marches to reach water and were then glad to camp beside any mud-puddle that contained enough water for ourselves and mules for a night. In 5 days more, we reached Adigrat, where I met the nephew of Prince Sayum, who is also a prince and a very important chief, although only 11 years old.

In the morning of September 23, our caravan was again on the way, and by afternoon we were camping in a small native village at the boundary line between Abyssinia and the Italian colony of Eritrea. Another day's travel brought us to Senafe, where I was cordially greeted by Major Tommasini, the commander of the Italian garrison, and was treated with splendid courtesy and hospitality by him and the other officers.

Another day's march brought us to Adi Caieh, where the Italians have built quite a town, now governed by civil authorities as well as military. The following morning, September 27, was the greatest festal day of the year, and was celebrated with dances, songs, rifle firing, and blowing of trumpets. Two days later we came to Saganeti, another army post, and reached Asmara on October 1. The caravan was paid and dismissed. The journey of 500 miles had been made in 2 months and 4 days, including stops at 11 stations for the purpose of making observations, and it had been made without any serious accident, and with the loss of only one mule, which died of exhaustion. I presented my letter of introduction furnished by the Italian Minister at Addis Abeba to the Governor, and on his suggestion I called on Professor Baldrati, who pointed out the location of the magnetic station of Professor Palazzo. From Asmara I went by train to Massaua and occupied a station of Professor Palazzo there also.

I then embarked for Suez, whence I went by train to Alexandria, and sailed for Tripoli by way of Syracuse. At Tripoli I called on the American Consul, Mr. William Roderick Dorsey, who had succeeded Mr. Wood, and through him obtained an interview with the Governor of Tripolitania. Again we discussed the feasibility of an expedition southward into the desert. As before, I was advised that such an expedition could not be permitted, for the reason that, owing to the war in Europe, almost all

the soldiers had been withdrawn from the interior and sent to Italy. A few days later, acting upon instructions cabled from the Office, I left for Washington by way of Syracuse, Naples, and New York, arriving at the Office on December 8.

Table 34 gives names of stations, dates of occupation, and geographic positions. The magnetic data are given for 1913 in Volume II of these *Researches*, and those for 1914 in the present Volume (see Table of Results).

TABLE 34.

No.	Name[1]	Date	Lat. North		Long. East	
		1913-14	°	′	°	′
1	*Rome*	Nov. 7–10	41	57.5	12	28
2	*Terracina*	" 12–17	41	17.7	13	15
3	Messina	" 29–30	38	12.2	15	35
4	*Palermo*	Dec. 6–10	38	07.4	13	19
5	*Tripoli*	" 17–18	32	53.9	13	11
6	Tajura	" 21–22	32	53.2	13	22
7	Misurata	Jan. 1–2	32	23.2	15	06
8	Syrte	" 6–10	31	12.6	16	33
9	Bengasi	" 20–22	32	05.2	20	06
10	Tolmetta	" 29, Feb. 1	32	43.9	20	56
11	Marsa Susa	" 8–9	32	54.5	21	58
12	Derna	" 15–17	32	45.6	22	39
13	Tobruk	" 21, 24	32	06.0	23	57
14	*Alexandria*	Mar. 7–8	31	16.4	30	00
15	*Helwan*	" 12–14	29	51.6	31	20
16	Barrage	" 20–21	30	12.5	31	10
17	El Omeiyid	Apr. 13	30	48.4	29	14
18	Daba	" 15–16	31	02.6	28	29
19	Rail Head	" 19	31	08.8	27	46
20	Matruh	" 23	31	22.8	27	16
21	Negeiyila	" 27	31	29.4	26	40
22	Barrani	" 30	31	37.4	25	56
23	Sellum	May 3–4	31	34.3	25	10
24	*Suez*	" 19	29	57.9	32	33
25	*Port Sudan*	" 27–28	19	37.4	37	14
26	*Aden*	June 3	12	47.1	44	59
27	Jibuti	" 7	11	34.2	43	08
28	Aicha	" 10–11	10	44.6	42	37
29	Dire Daoua	" 16	9	34.9	41	54
30	Afdem	" 19	9	27.8	41	04
31	Hawash	" 24	8	59.0	40	14
32	Ula Ula	" 30–July 1	8	53.2	39	41
33	Addis Abeba	" 15–17	9	00.8	38	46
34	Goolaba	" 31	9	19.7	39	10
35	Gimbaro-Mariam	Aug 5	9	43.8	39	33
36	Angowa	" 11	10	11.2	39	41
37	Antorkia	" 16	10	38.1	39	39
38	Dessié	" 20–21	11	06.5	39	33
39	Waldea	" 31	11	48.0	39	34
40	Balla	Sep. 5	12	26.0	39	43
41	Adi Musseno	" 10	13	01.3	39	34
42	Makalle	" 15–16	13	30.3	39	28
43	Sedua	" 21	14	07.6	39	34
44	Adi Caieh	" 26	14	51.3	39	23
45	Asmara	Oct. 4–5	15	21.0	38	56
46	*Massaua*	" 7–8	15	36.2	39	27
47	*Tripoli*	Nov. 4–5	32	53.9	13	11

[1] The stations are in the following countries: Nos. 1 to 4, Italy; Nos. 5 to 8, 47, Tripolitania; Nos. 9 to 13, Cyrenaica; Nos. 14 to 24, Egypt; No. 25, Anglo-Egyptian Sudan; No. 26, Arabia; No. 27, French Somaliland; Nos. 28 to 43, Abyssinia; Nos. 44 to 46, Eritrea.

The total time of the trip was 410 days, while the time spent in the field was 383 days, making the average field time about 8 days per station. The total distance traveled in the field was 8,699 miles, of which 2,423 were by train, 5,530 were by steamer, 580 were by mule, and 166 were by camel. The average distance between stations was about 185 miles. The average cost per station was about $57.

D. M. WISE, ON MAGNETIC WORK IN BELGIAN CONGO, ANGOLA, AND ADJACENT COLONIES, JANUARY 1914 TO JUNE 1915.

In accordance with instructions dated December 19, 1913, and January 24, 1914, I left New York January 31, 1914, for Funchal, Madeira, with instrumental equipment as follows: theodolite-magnetometer No. 16; Dover dip circle No. 222 with needles Nos. 1, 2, 5, and 6; pocket chronometer; 3 watches; tripod; observing tent; and various other accessories.

Madeira was reached on February 7, and after reoccupying both magnetic stations, the journey was continued to Santa Cruz, Teneriffe; Las Palmas, Grand Canary; and Conakry in French Guinea. After waiting a week at Conakry, I embarked upon the Belgian steamer for Boma, where I arrived March 9. Before proceeding up the river to Matadi, several days were spent at Boma in attending to various matters of the expedition. From Matadi the journey was continued by rail to Thysville and thence to Kinshasa, about 340 miles from the coast. The latter place was reached on March 19, and final preparations made for the long trip to the interior. Some time was spent in learning enough of one of the native languages (Bangala) to enable me to secure efficient service from native servants who, in this region, speak no European language. Much information was collected from various travelers concerning the conditions and customs of travel in the districts included in the proposed itinerary.

We left Kinshasa on March 30, and the trip of 1,000 miles to Stanleyville was completed on May 11, entirely by river steamers, some owned by the Belgian government, others by commercial companies. Stops were made at intervals for observations and always entailed more or less delay in waiting for another steamer. The weather was very hot, and violent tornadoes were frequent during this season, but caused no delays.

It had been planned to proceed from Stanleyville or vicinity northeastward to Lado in Anglo-Egyptian Sudan and return, but as the trip would have been a long one, entirely on foot, and as the rainy season was just beginning north of the equator, it was decided to postpone it and travel southward where a dry season would favor both travel and observations. Accordingly, the trip around the Stanley Falls cataract region to Ponthierville was undertaken and accomplished by May 20, and Kindu, 250 miles up the Lualaba River, was reached June 2, the trip having been made on river steamers operated by the Great Lakes Railway Company. At Kindu we again entrained on the railway to pass around the unnavigable portion of the river in the Kasongo district, 2 days being required to reach Kongolo, 230 miles distant. The 50-mile trip to Kabalo, the river terminus of the Tanganyika Railway, was made by steamer on June 9, and on June 11 the journey was continued up the Lualaba River 55 miles to Ankoro.

It was desirable to return to Kabalo to branch out on side trips before continuing up the Lualaba, but several days were lost in looking for a suitable boat and boatmen for the down-stream trip. A large surf boat and 10 paddlers were finally secured, and the trip accomplished on June 15 and 16, the whole night being spent on the river. It was imperative to make haste at this time, as the constantly decreasing depth of water in the Lualaba momentarily threatened a discontinuance of the steamer service to Bukama, our ultimate destination. There was time, however, for a side trip from Kabalo, which was made by construction trains on the Tanganyika Railway eastward to within about 25 miles of Lake Tanganyika. Kabalo was again reached on June 21, but no steamer arrived before June 26 bound up the Lualaba. On that date the trip of 365 miles to Bukama began and was completed on July 7. That so much time was taken was due mainly to the stage of water which was so low, in many places, that the steamer was literally dragged over the sand-banks by attaching a line to trees farther up-stream and drawing up to them by means of winches.

Heretofore practically all transportation had been accomplished by steam, but, Bukama being the head of navigation, it was necessary to continue the journey by means of a caravan of native carriers. It is generally very difficult and expensive to obtain carriers from Bukama, but I had the good fortune to meet a contractor whose carriers were going to Kambove without loads, and with whom satisfactory arrangements were made for transporting the baggage to the rail-head, thence the journey of 45 miles to Kambove was completed by construction train on the night of July 23. Some days were spent in Kambove making observations and waiting for a train. The railway trip to Elisabethville, a distance of 100 miles, was made on July 28, and later a trip was made by rail to Sakania, and return.

Owing to the outbreak of the European war at this time, the plans for the succeeding work had to be considerably modified. Instead of proceeding southward to Cape Town, it was considered best to work farther in the interior, and to that end a caravan trip from Kambove to Luebo was planned. The distance to be traversed was upwards of 800 miles, so that considerable preparation was necessary. Food supplies were purchased, and a bicycle for myself, on the advice of men who had traveled over portions of my proposed route. The bicycle proved most useful, and enabled me to make the trip entirely without hammock carriers. Difficulty was encountered in obtaining the required number of carriers, but on August 14 all preparations were complete. I departed next day from Kambove with a caravan consisting of 25 carriers, one servant, and a cook who could speak English and who proved very valuable as an interpreter.

On September 5, we arrived at Kafakumba, where I was cordially received by the Belgian officials. My carriers were sent back and new ones engaged with the aid of the Commandant. On September 10 we resumed the journey, and arrived, September 22, at Kapanga, where another complete change of carriers was necessary. There was some difficulty in finding carriers who would go through the region we wished to traverse, because the tribes to the northward had a bad reputation. Carriers were finally secured, however, and the journey continued on September 25. Up to this time the weather had continued dry, the country was rather flat and open and water was scarce. Five or 6 hours were often required to march from one stream to the next, but after leaving Kapanga everything was changed. The country was more mountainous. Rains occurred every afternoon, and streams and swamps were more numerous. The natives, however, were much less friendly, which made it difficult at times to secure food for the carriers. At the native village Mutunda, a halt was made on October 9 and 10, to replace a number of carriers, after which we continued to Luebo, where we arrived on October 19. From Luebo the journey was continued by steamer on the Lulua and Kasai rivers to Basongo, where the Sankuru River joins the Kasai. The Sankuru was ascended to Lusambo, thence returning and continuing down the Kasai to the Congo and down the latter, I finally arrived at Kinshasa on November 20, after nearly 8 months of travel. From Kinshasa I crossed over to Brazzaville to make the journey to the coast overland, but this was finally abandoned owing to weather conditions, and I returned via Matadi to Boma, whence a trip was made by rail northward to Tshela and return.

From Boma, I proceeded by launch to Banana and thence in a small steamer to St. Paul de Loanda, Angola, where I arrived December 24. A number of days was spent in attending to expedition matters. A trip by rail of about 300 miles to Malange was begun January 5, and the return to Loanda completed on January 16. On January 19 I sailed for Benguela, from which place I traveled by railway to the rail-head at Chinguar (or Xinguari), about 300 miles; view 2 of Plate 3 is a typical station. The return was made to Lobito, where I arrived February 10. It was necessary to secure other official letters before I would be permitted to go farther south, and for that purpose I returned to Loanda, secured the necessary letters, and sailed for Mossamedes on

March 1. From there I sailed south to Tiger Bay, Angola, and then began the return northward. Delays were occasioned waiting for steamers at all these places. On the trip northward, rough weather caused several days' delay at Benguela, and at Loanda 10 days were lost during coaling. I arrived at Cabinda, Angola, on March 30, and continued on foot to Loango in French Congo, where I took a coasting steamer bound northward and arrived at Libreville on April 22.

Cabled instructions were received at Libreville to return to Washington, and the journey was resumed on the same steamer on which I had arrived. Elobey and Bata in Spanish Guinea, Santa Isabel in Fernando Po, and Douala in the Cameroun were visited before reaching Lagos, Nigeria, on May 5. A delay of 2 weeks occurred here while waiting for a steamer, which left Lagos May 20 and arrived at Las Palmas on May 31. Las Palmas and Santa Cruz (see view 4 of Plate 7) were reoccupied, and on June 12 I left Las Palmas for Washington via Boco Grande, Florida. On June 29 I reported at the Office in Washington.

Table 35 shows the stations established, with dates and geographic positions; the magnetic data are given in the Table of Results.

TABLE 35.

No.	Name[1]	Date	Latitude	Long. East
		1914	° ′	° ′
1	*Funchal*	Feb. 9–11	32 38.0 N	343 05
2	*Santa Cruz*	" 15	28 28.0 N	343 44
3	*Conakry*	" 26	9 30.8 N	346 16
4	Boma[3]	Mar. 11–12	5 51.5 S	13 04
5	Thysville	" 17–18	5 15.1 S	14 54
6	Leopoldville, *A*[3]	" 23–24	4 19.7 S	15 14
7	Kwamouth[3]	Apr. 3–4	3 10.7 S	16 16
8	Bolobo, *A*	" 8	2 09.6 S	16 17
9	Lukolela[3]	" 14–17	1 02.8 S	17 14
10	Coquilhatville[3]	" 23	0 03.9 N	18 18
11	Lisala	" 29	2 08.4 N	21 32
12	Bosoko[3]	May 4	1 13.5 N	23 38
13	Stanleyville[2]	" 13–16	0 31.0 N	25 11
14	Ponthierville[3]	" 20–21	0 22.1 S	25 24
15	Lowa[3]	" 26–27	1 23.8 S	25 47
16	Waika	" 30–June 1	2 23.3 S	25 41
17	Kindu	June 2–3	2 56.8 S	25 55
18	Malela	" 5–6	4 24.0 S	26 08
19	Kongolo	" 7	5 23.0 S	27 02
20	Kabalo	" 10	6 03.1 S	26 56
21	Ankoro	" 12–13	6 44.4 S	26 59
22	Kilometer 225	" 18–19	5 53.3 S	28 53
23	Kilometer 123	" 20	5 57.4 S	28 02
24	Kadia	July 1–2	8 16.0 S	26 38
25	Bukama	" 8	9 11.6 S	25 52
26	Mazanguli	" 13	9 43.9 S	25 44
27	Kapiri	" 19–20	10 19.0 S	26 14
28	Kambove	" 25–27	10 52.8 S	26 37
29	Elisabethville	" 31	11 40.0 S	27 29
30	Sakania	Aug. 3–4	12 45.0 S	28 33
31	Tshinsenda	" 6–7	12 18.2 S	27 58
32	Ruwe	" 21–22	10 40.7 S	25 32
33	Kimbundji	" 24	10 53.1 S	25 02
34	Kayoyo	" 29	10 34.9 S	24 16
35	Sakepalo	Sep. 3	9 50.7 S	23 52
36	Kafakumba	" 6–7	9 40.7 S	23 41

[1] The stations are in the following countries: No. 1, Madeira; Nos. 2, 89, and 90, Canary Islands; No. 3, French West Africa; Nos. 4 to 55, and 57 to 60, Belgian Congo; Nos. 56, 82, 83, French Equatorial Africa; Nos. 61 to 81, Angola; Nos. 84 and 85, Spanish Guinea; No. 86, Cameroun; No. 87, Fernando Po Island; No. 88, Nigeria.

[2] Point previously occupied by Delporte and Gillis.

[3] Point previously occupied by Lemaire.

TABLE 35—*Concluded.*

No.	Name	Date	Latitude	Long. East
		1914–15	° ′	° ′
37	Ulamba	" 13	9 16.8 S	23 25
38	Tshitaia	" 16	8 59.6 S	23 10
39	Kapanga	" 22–24	8 25.6 S	22 31
40	Tshiwana	" 27	7 56.2 S	22 47
41	Mukomwela	" 30	7 43.8 S	22 58
42	Tshibangu	Oct. 4	7 12.1 S	23 03
43	Kyembi	" 7	6 41 S	22 49
44	Luluabourg[1]	" 13	6 01.9 S	22 19
45	Fardiala	" 16–17	5 34.4 S	21 48
46	Luebo	Oct. 20–21	5 20.0 S	21 24
47	Djoka Punda	" 24	5 27 S	20 59
48	Bashishombe	" 25–26	4 39.1 S	21 00
49	Basongo	" 27–28	4 19.2 S	20 22
50	Bolombo	Nov. 2	4 01.2 S	21 22
51	Lusambo	" 7	4 58.3 S	23 26
52	Bena Dibele	" 9	4 06.9 S	22 51
53	Eiolo	" 14	3 42.9 S	18 56
54	*Leopoldville, B*	" 24–25	4 19.7 S	15 14
55	Dima	" 18	3 16.3 S	17 31
56	Brazzaville	" 29–30	4 17.0 S	15 17
57	Matadi	Dec. 11	5 49.4 S	13 28
58	*Boma*	" 20	5 51.5 S	13 04
59	Tshela	" 16–17	5 00.2 S	12 58
60	Banana[2]	" 22	6 00.4 S	12 26
61	Loanda[3]	" 31	8 48.8 S	13 14
62	Cassoalala	Jan. 6	9 29.6 S	14 22
63	Lucala	" 8–9	9 16.7 S	15 15
64	Malange	" 12	9 33.0 S	16 21
65	Cabiri[3]	" 15	8 53 S	13 38
66	Benguela	" 22	12 34.6 S	13 24
67	Cuma	" 24–25	12 52.2 S	15 02
68	Cubal	" 26	13 02.9 S	14 16
69	Huambo, *A*	" 29	12 46.3 S	15 45
70	Chinguar	Feb. 1–2	12 33.7 S	16 23
71	Catengue	" 8	13 01.5 S	13 44
72	Lobito, *A*	" 14–15	12 20.9 S	13 34
73	Novo Redondo	" 21	11 11 S	13 48
74	Loanda Island[4]	" 24	8 46.8 S	13 14
75	Mossamedes[4]	Mar. 7	15 10.9 S	12 09
76	Tiger Bay	" 10	16 35 S	11 44
77	Port Alexandre	" 12	15 47.6 S	11 49
78	*Loanda*	" 19–20	8 48.8 S	13 14
79	Ambriz	" 29	7 49.7 S	13 02
80	Cabinda	Apr. 1	5 32.3 S	12 12
81	Chiloango	" 6	5 12.1 S	12 08
82	Loango	" 9–10	4 38.4 S	11 48
83	Port Gentil	" 16–18	0 42.6 S	8 46
84	Elobey	" 26	1 00.6 N	9 30
85	Bata	" 27	1 52.5 N	9 45
86	Douala	" 29	4 02.4 N	9 43
87	Santa Isabel	May 2	3 46 N	8 47
88	*Lagos, C*	" 17	6 26.9 N	3 24
89	*Las Palmas*	June 4	28 07.6 N	344 35
90	*Santa Cruz*	" 8	28 28.0 N	343 44

[1] Point previously occupied by Oliver.
[2] Point previously occupied by Delporte and Gillis.
[3] Point previously occupied by United States Coast and Geodetic Survey.
[4] Point previously occupied by British Admiralty.

I was absent from the office a total time of 515 days, and counting from arrival at Boma, Belgian Congo, until departure from Lagos, Nigeria, I spent 437 days in the field. The average field time per station is 5.1 days. The total distance covered on the trip was about 23,200 miles, of which only 9,300 miles were actual field travel, the remaining 13,900 miles representing travel between Office and field. The field travel per station was 109 miles. Of the travel to and from field, 12,585 miles were by ocean steamer and 1,315

miles by railway. In the field the distance traveled may be divided as follows: Ocean steamer, 3,182 miles; river steamer and launches, 2,915 miles; railway, 2,075 miles; on foot, 1,068 miles; and canoe, 60 miles. An average distance of 45 miles was covered for every day absent from the Office. The average cost per station was about $58.

No marked local magnetic disturbance was noticed except at Funchal, Madeira, and at Djoka Punda, the limit of navigation on the Kasai River, Belgian Congo. At no time were observations delayed or rendered impossible by magnetic storms.

Cordial assistance was rendered by the consular officers of the various ports, especially by Mr. McBride, United States Consul-General at Boma; Mr. H. H. Castens, British Consul-General at Boma; Mr. Hall-Hall, British Consul-General at Loanda; and Mr. H. Campbell, acting Consul at Boma. Much of the success of the Congo trip was due to the courtesy and kindness of all the officials in Belgian Congo. Governor-General Fuchs provided me with valuable letters to the district officials in the interior, and Commandant Willemoës D'Obry, chief of the Hydrographic Service, gave information and assistance. Thanks are also due to the officials of Angola, French Congo, and Spanish Guinea. Mr. Adam, Engineer-in-Chief of the Grand Lakes Railways, arranged for travel on the Tanganyika construction. Throughout the trip the hospitality and kindness of the missionaries did much to make things pleasant.

D. M. Wise, on Magnetic Work for Selection of Observatory Site in Northwestern South America, September 1916 to February 1917.

In accordance with the Director's instructions of September 15, 1916, I set out from Washington on September 27 to carry out survey work along the west coast of South America, and to search for a suitable site for the proposed observatory in Peru. I was joined in New York by Observer Allen Sterling, and together we sailed from New York on September 30 for Colon via Havana. We were equipped with theodolite-magnetometer No. 10, universal magnetometer No. 21, earth inductor No. 5, galvanometer No. 30X, 2 pocket chronometers, 4 watches, 2 observing tents, and other miscellaneous appurtenances.

We arrived at Colon October 9, having made observations at the Villa Observatory of the Jesuit Society at Havana during the brief stay of our steamer there. Two stations in Colon were reoccupied before proceeding down the Colombian coast aboard the steamer *Cauca* bound for Guayaquil, where we arrived October 26. From Guayaquil, Callao was reached by steamer in 5 days, but as the quarantine regulations require 6 days to be completed from Guayaquil, it was necessary to spend one day in quarantine before we were permitted to land on November 10. The remainder of November was spent in getting information pertaining to the location of a suitable observatory site, making some needed repairs to equipment, and completing observations at Lima and Matucana. During the first part of December, stations were occupied at Huacho and Sayan; the latter part of the month was spent examining the region close to Yangas, about 40 miles northeast of Lima, to determine whether it was sufficiently free from disturbing magnetic influences for an observatory site. We proceeded from central Peru to its southern port, Mollendo, arriving on New Year's morning. After observing there, we traveled by train to Arequipa, where we were cordially received by Mr. Hinkley, observer-in-charge of the Harvard College Observatory. We made intercomparisons of our instruments on the Observatory grounds, and while doing so stayed with Mr. Hinkley at the Observatory quarters, which very much facilitated our work.

In accordance with cabled instructions received January 25, 1917, Mr. Sterling proceeded alone to carry out the work assigned him along the coast of Chile, while I returned to Lima to join Mr. Fleming on February 15, and continued a member of his party until May 1, 1917.

Table 36 gives names of the stations occupied, with dates of occupation and geographic positions; for magnetic data, see Table of Results.

TABLE 36.

No.	Name [1]	Date	Latitude	Long. East
		1916	° ′	° ′
1	*Havana*	Oct. 5	23 06.4 N	277 39
2	*Colon, Sweetwater, A*	" 10	9 21.3 N	280 03
3	*Colon, Washington Hotel*	" 11–12	9 22.0 N	280 05
4	*Tumaco*	" 21–22	1 48.3 N	281 14
5	*Quito*	" 29	0 13.1 S	281 20
6	*Riobamba*	" 31	1 39.5 S	281 18
7	*Guayaquil*	Nov. 2–3	2 10.8 S	280 09
8	*Lima, Hipodromo*	" 13–15, Dec. 28	12 04.3 S	282 58
9	*Matucana*	" 24–25	11 50.8 S	283 36
10	*Huacho*	Dec. 1–2	11 06.7 S	282 22
11	Sayan	" 9–10	11 08.4 S	282 48
12	*Yangas, A, B, C, D, E*	" 19–25	11 41.8 S	283 10
		1917		
13	*Mollendo*	Jan. 2	17 01.8 S	287 59
14	*Arequipa, A, B*	" 5–30	16 22.5 S	288 27

[1] The stations are in following countries: No. 1, Cuba; Nos 2 and 3, Panama; No. 4, Colombia; Nos. 5 to 7, Ecuador; Nos. 8 to 14, Peru.

Owing to the fact that the work of the party was not in the nature of the ordinary magnetic survey, the averages per station are not truly representative for survey statistical data. Fourteen stations were occupied in 138 days, averaging nearly 10 days per station. We traveled in all about 5,900 miles, of which about 600 miles were by rail. The average cost was about $108 per station for field expense.

No very marked local magnetic disturbances were noted, although the sand along the entire coast of Peru contains a great quantity of magnetic particles, which cling to a magnet like iron filings.

During the whole trip we were received with the greatest courtesy and consideration. The American diplomatic and consular officers rendered much assistance. The Minister of Interior of Peru, through Señor G. Cisneros y Raygada, furnished us with valuable letters of introduction to local officials concerning free entry of instruments and equipment; Señor José A. de Iscue, secretary, and Señor Salvador del Solar, engineer, of the Junto Departamento de Lima, were both very active in aiding us in many ways.

D. M. WISE, ON MAGNETIC WORK IN PERU, MAY TO SEPTEMBER 1917.

In accordance with instructions of April 30, 1917, received through Mr. J. A. Fleming at Lima, Peru, I began on May 1, 1917, to arrange for conducting a magnetic-survey expedition into central and northern Peru. Mr. Bradley Jones, who had been detached from the *Carnegie* party at Buenos Aires, joined my party on May 3, and together we reoccupied my Lima station of 1916, purchased provisions, equipment, and gear, and obtained what information was available concerning the difficult interior trip which had been assigned us. The instrumental equipment, sufficient for two parties, which was carried from Lima, consisted of theodolite-magnetometer No. 10, magnetometer-inductor No. 28, dip circle No. 202, 2 observing tents, three pocket chronometers, 2 watches, and the miscellaneous accessories usually carried by a magnetic-survey party. After the joint occupation of a few stations, Mr. Jones and I were to separate and cover different routes.

We proceeded from Lima to Oroya on May 16, the trip being made over the Central Railway of Peru, which crosses the western Andes 15,670 feet above the sea-level.

Two days were spent in reoccupying Mr. Ault's 1912 station at Oroya, and in trying to accustom ourselves to the altitude before continuing to Cerro de Pasco, where observations were made later. It had been planned to make other observations in this vicinity, but as Mr. Jones had been violently ill from soroche or mountain sickness from the day of our arrival at Oroya, it was deemed advisable to curtail our work and begin our descent to a lower altitude as soon as possible. Accordingly, on May 22 we left Cerro de Pasco on horse-back, with a 3-mule luggage caravan. In a remarkably short time after beginning the descent, all signs of soroche disappeared, and we enjoyed the strange sensation of riding in one day from an icebound mining town to a valley in which many varieties of tropical fruits were then ripening.

Guided by information which we had been accumulating along the way, we radically modified our plan on reaching Huanuco, 2 days later, and decided to leave behind magnetometer No. 10, dip circle No. 202, and one observing tent, arranging to complete the expedition in company. In accordance with this decision, intercomparisons of instruments were carried out at Huanuco, and the above-named part of our equipment was packed and sent back to Lima, there to be stored until our return. Final preparations were made for our descent of the Huallaga River, and having procured mules, we set out on June 4 for the 3-day trip to Vista Alegre, an hacienda which marked the end of the mule trails. After making observations at Hacienda San Juan, all our luggage was rearranged in convenient form for transportation by Indian carriers, who were secured through the kind assistance of the hacendados of Vista Alegre and San Juan, for the trip to a point from which it would be possible to navigate the Huallaga. Haciendas Vista Alegre and San Juan are both engaged in the cultivation and preparation of coca, which is universally used by the Indians in the mountain regions of Peru. Every man and woman carries a small woven or leather bag containing the dried coca leaves and a little gourd bottle of unslaked lime. The addition of a little lime is necessary to make the "chew" properly effective. We were invariably obliged to furnish coca to secure men as carriers or as arrieros, the average man requiring from 4 to 8 "chews" per day. Indeed, on one part of our trip we were much confused by encountering an unfamiliar unit of distance, as all our inquiries concerning distances elicited replies only in terms of "coquiadas." After a while we learned that a "coquiada" was the distance which a carrier would normally cover between stops to chew coca.

Tingo Maria, reached after 3 days on foot with a caravan of 6 Indians carrying our luggage over trails that have been very fittingly described as "monkey roads," is a settlement of about 8 families located at the junction of the Monson River with the Huallaga, and is controlled by Señor Mariana Rosales. At the time of our arrival and for several days subsequent thereto, the community was celebrating the feast day of its patron saint, and consequently was quite incapable of giving to us much attention, information, or assistance. Hospitality was extended by Señor Rosales, however, and we were energetically and persistently invited to assist in the celebration by partaking of their aguardiente and chicha, and by setting off rockets.

Magnetic observations were made, and after the feast days we secured one man as guide and a balsa or raft of 5 poles bound together with bark and just sufficiently buoyant to float ourselves and our luggage. On June 15 we launched our strange craft on the waters of the Huallaga, that mysterious stream of which we had been able to learn so little even up to this point. Our guide sat upon the bow of the balsa in water to his knees, steering with an enormous paddle past shoals and rocks, snags and whirlpools, in a current so rapid that it gave but little time for recovering poise from one river phase to the next. The splashing water in the rapids kept us continually soaked, and often it was also necessary to get out in the stream and lower the raft by ropes over a particularly shoal place or past a snag against which the current set too strongly. Neither

was it unusual after such an experience for the observer to have to swim after the raft, trying to get aboard before the next "white water" should be reached.

At the end of the second day we came to Ancayaco, the first human habitation on our voyage, where we procured without delay the services of another guide and a large dugout canoe to replace our balsa, already considerably the worse for wear. In addition, our new guide took for his return trip a very small canoe and his 11-year old son to assist in poling it up stream, as the large canoe was to be left at Putante. This guide was not as expert a boatman as we had reason to expect, and on the second day the large canoe, striking on a partly submerged snag, capsized and spilled its contents in the river. After recovering everything possible, we found that we had lost all of our time pieces with the exception of my own personal watch, our kodak and films, a considerable sum of money, and many items of smaller value. After spending all the following day in fruitless efforts for the recovery of the lost articles, we proceeded to Putante, the port for the town of Uchiza.

As we had now remaining only the one watch, it was decided best to abandon our intention of continuing down the Huallaga to Yurimaguas, and instead to return to Lima by the quickest possible route. After several consultations with the people of Putante, it was decided to go via Huacrachuco to Chimbote, the nearest seaport, and therefore our attention was turned to securing carriers to transport our equipment. Observations were made, Indians secured, and June 20 saw us begin on foot the first stage of our journey to the coast, with a caravan of 6 carriers. For the first few days the trail led through the thick tropical growth of the Montaña, following closely up the winding course of the river Chontayaco. Observations were made at the edge of the Montaña, where the jungle gradually gives way to the barren mountain slopes and the grades rapidly increase until the trail crosses the divide close to the only snow-cap in sight east of the Marañon. Huacrachuco was reached on July 10, although it was not until July 14 that we were able to obtain mules with which to continue our trip. Proceeding from Huacrachuco, we climbed for half a day, then dipped at once into the cañon of the Marañon. It took us 2 days to cross this gorge, for although the airline distance was probably no more than 10 miles, the vertical distance traversed was more than one-third of this. Our guides proved to be not very conversant with the route we were attempting and consequently we lost several days trying to find a way to get to the pass over the snow-covered, forbidding looking mountain range before which we were zig-zagging back and forth. After passing several very uncomfortable nights because of the cold, we finally passed the summit of the western range on July 20, and dropped in a couple of days from there down to the end of the railroad at La Limeña.

The last stage of this journey was over a very rough road cut in the sides of the rock cañon of the Santos River. At places along the road, tunneling had been resorted to, and at the first of these tunnels which we encountered we found our dexterity as mule-handlers put to a severe test. We could not ride through. Pulling the mules was equally unsuccessful. Blindfolding proved useless. Even Kechua profanity did not help us. A candle as a head-light solved the problem, and all the succeeding tunnels were passed in that manner without difficulty or loss of time.

Our guide and mules having been sent back, we made observations before proceeding by rail to Chimbote, where the 1912 station was reoccupied, and arrangements were made to proceed to Lima via the port of Salaverry. We arrived in Lima on July 30, and received supplementary cabled instructions calling for Mr. Jones's return to Buenos Aires and my return to Washington. I returned via New Orleans, arriving in Washington on September 1, 1917.

The total time consumed in the above work was 124 days. Deducting the time spent in preparation in Lima and in returning to the Office, in all 46 days, there remain

78 days of actual field work, giving an average of 6½ days per station. The total travel, including the return to Washington, amounted to 5,150 miles, of which 940 miles were field travel, making an average of about 78 miles field travel per station.

The stations occupied during this trip, with dates and geographic positions, were as listed in Table 37 below; for magnetic data, see Table of Results.

TABLE 37.

No.	Name [1]	Date	Lat. South		Long. East	
		1917	°	′	°	′
1	*Lima*	May 1,7	12	04.3	282	58
2	*Oroya*	" 18	11	32.6	284	05
3	Cerro de Pasco	" 21	10	41.3	283	45
4	Huanuco, *A*, *B*	" 26-30	9	56.1	283	45
5	Hacienda San Juan	June 7	9	31.2	284	08
6	Tingo Maria	" 13-14	9	17.1	284	07
7	Hacienda Putante	" 21-22	8	24.2	283	53
8	Shiraca	July 5-6	8	39.0	283	37
9	Huacrachuco	" 11	8	36.2	283	07
10	Andomayo	" 19-20	8	38.6	282	22
11	La Limeña	" 22	8	40.5	281	56
12	*Chimbote*	" 24	9	04.1	281	25
13	*Lima*	Aug. 8-9	12	04.3	282	58

[1] All the stations are in Peru.

The results obtained do not indicate any unusual local magnetic disturbances despite the fact that at almost every station occupied the sand or loam contained particles of of iron ore which could be separated by the use of a magnet, such iron being particularly plentiful along the western coast. At the higher altitudes, the observing tent collected high static charges so that discharges would occur whenever the observers got close to the tent.

The officials of Peru were very courteous and did everything possible to facilitate the work of the expedition. As on various former occasions, the official through whom all negotiations were conducted was Señor G. Cisneros y Raygada, Introductor de Ministros, whose active assistance and interest were much appreciated. The hospitality accorded by all the haciendas and chacras within the Montaña was very cordial. I wish particularly to mention Señor Trujillo of Hacienda San Juan and Señor Aguilo of Uchiza.

SYNOPSES OF ADDITIONAL MAGNETIC SURVEYS, 1914 TO 1920.

Besides the expeditions for making magnetic observations which are briefly described in the foregoing reports, the following work has been done in the period 1914 to 1920:

Roald Amundsen.—Cooperative arrangements were entered into between the Department of Terrestrial Magnetism and Captain Roald Amundsen, leader of the "Maud Expedition" to the Arctic: Captain Amundsen offered to furnish copies of all magnetic observations made on the expedition; the Department provided the necessary magnetic instruments for Arctic work (see p. 8 and Pl. 2) and program of observational work, and it engaged to make the reductions of the observations as required. Magnetometer No. 8 and dip circle No. 205 were the instruments furnished, together with the usual accessories and additional equipment demanded by the nature of the contemplated work. The expedition left Christiania, Norway, in July 1918, and spent the following winter at a point called Maud Haven on the Siberian coast in east longitude 105° 40′. Here a temporary observatory was constructed of logs and driftwood, and provided with 2 piers on which observations were made during the stay at that place. Short inland trips were made on which some magnetic work was done during April and May 1919. The winter of 1919-1920 was spent at winter quarters on the coast in east longitude

167° 43′ and the usual winter observations were carried out. In July 1920 the party arrived at Nome, Alaska, and after a brief visit set out for the north again to begin the drift across the polar seas.

J. P. Ault.—In October 1917 Mr. J. P. Ault reoccupied the United States Coast and Geodetic Survey station at New London, Connecticut, and established 5 additional stations in the immediate vicinity for the purpose of controlling compass-variometer observations made on the waters around New London in connection with experiments made to improve the form of that instrument for marine use.

L. A. Bauer.—At the conclusion of special observations at the time of the eclipse of June 8, 1918, the Director, Dr. L. A. Bauer, proceeded to Manitou, Colorado, where he personally supervised the work of making a detailed magnetic survey of the region about Pikes Peak. He was assisted by Messrs. W. J. Peters, H. W. Fisk, and C. C. Ennis, who made observations at 24 points in the vicinity, including 3 stations on the summit of the mountain. Additional stations were occupied at about the same time by observers of the United States Coast and Geodetic Survey. The stations were selected at different altitudes, ranging from about 6,000 feet at Colorado Springs to over 14,000 feet on the summit of Pikes Peak, distributed around the mountain at such points as were available for the purpose; views 2 and 3 of Plate 5 are typical of these stations. During the time this work was in progress, the magnetograph instruments set up at Lakin, Kansas, for the eclipse work were kept in operation in charge of Mr. D. M. Wise.

On the total solar eclipse expedition of 1919 to Cape Palmas, Liberia, Dr. L. A. Bauer, in company with Mr. H. F. Johnston, determined the magnetic elements at the eclipse station and at points in the immediate vicinity. The details of this expedition are given in the special report on the eclipse observations of May 29, 1919.

F. Brown.—Mr. Brown concluded his trip across Africa from Benguela to ports on

TABLE 38.

No.	Name	Date	Lat. South		Long. East	
		1920	°	′	°	′
1	Majunga, *A*	Oct. 18	15	42.9	46	19
2	Majunga, *B*	" 15–16	15	43.4	46	19
3	Maevatanana, *A*	" 24	16	56.3	46	48
4	Maevatanana, *B*	" 25	16	56.8	46	48
5	Antsiafabositra	" 27–28	17	18.4	46	56
6	Andriba	" 29	17	36.3	46	54
7	Mahatsinjo	" 30–31	17	44.3	47	00
8	Ankazobe	Nov. 4–5	18	18.9	47	06
9	Fihaonana	" 9	18	36.2	47	11
10	Tananarive Observatory, *A*	" 13–18	18	55.0	47	32
11	Tananarive Observatory, *B*	" 12–16	18	55.0	47	32
12	Tananarive	" 22	18	54.9	47	30
13	Antsirabe, *A*	" 26	19	52.2	47	00
14	Betafo	" 27	19	50.0	46	50
15	Antsirabe, *B*	" 28	19	51.9	47	00
16	Ambositra, *A*	Nov. 30–Dec. 1	20	31.8	47	13
17	Ambositra, *B*	" 2	20	32.4	47	14
18	Fianarantsoa, *A*	" 6–8	21	27.2	47	03
19	Fianarantsoa, *B*	" 7	21	27.2	47	02
20	Ambalavao	" 10	21	49	46	54
21	Zazafotsy	" 12–13	22	11.3	46	20
22	Ihosy	" 14	22	22.7	46	07
23	Lalana	" 16	22	55.0	46	06
24	Betroka	" 17–19	23	15.9	46	04
25	Ankatrafay	" 21	23	20	45	38
26	Ampasindrasoa	" 22	23	24.0	45	11
27	Benenitra	" 23–24	23	27.5	45	03
28	Tongobory	" 28	23	32.0	44	17
29	Tulear	" 31–Jan. 2, 1921	23	21.2	43	37

the Indian Ocean in October 1920, and immediately crossed over to Madagascar to undertake a magnetic survey of that island. He arrived at Majunga and established a station there about the middle of the month, then proceeded by steamer, by cart, and by carriers to Tananarive, establishing stations en route. As it was well known that large local disturbances exist at Tananarive and presumably at other points, special precautions were taken to secure representative values at each station, and accordingly whenever possible complete observations were made at a supplementary station in order to reduce the effect of assigning a highly disturbed value to the locality. At Tananarive a series of comparison observations was carried out with the instruments of the Tananarive Observatory during the month of November. Through the cordial cooperation of the colonial authorities, who rendered substantial assistance in providing transportation and hospitality, Mr. Brown arranged and by the end of the year had begun to carry out an extensive program of work which was to cover the whole island in a general way. The stations occupied before the end of December 1920 are given in Table 38.

C. K. Edmunds.—During the summer of 1914 Dr. Edmunds erected 2 small huts on the campus of Canton Christian College which were used as base-stations for the survey of China carried out during the next few years. Observations of diurnal variation in declination were made here at intervals during 1915 and while the survey was in progress, and special observations were made during the eclipse of August 21–22, 1914. Two short trips were made in 1914, one to Shekki and Macau south of Canton in July, and one in August to Sheklung and Loh Fau Shan, where observations were made near the top of the mountain at an altitude of about 4,000 feet. The latter journey was made by rail to Sheklung, about halfway between Canton and Hongkong, and thence by boat and by chair or on foot about 20 miles to the mountain, which is one of the highest peaks in the southern part of the province.

H. W. Fisk.—In September 1917 Mr. Fisk was directed to proceed to Langley Field, Virginia, for the purpose of determining the magnetic elements at a station on the aviation grounds for use in carrying out experiments in progress at that time. After supplying the desired information, the United States Coast and Geodetic Survey station at Hampton, Virginia, was occupied.

In order to properly control the observations made during swings of the *Carnegie* at the close of Cruise V and after extensive repairs and alterations in Baltimore before the beginning of Cruise VI, land stations were established along the shores of Chesapeake Bay in the neighborhood of the position of swing. Mr. Fisk, assisted by Messrs. H. R. Grummann and R. R. Mills, carried out the observations, using for the purpose magnetometer-inductor No. 25 and magnetometer No. 5, the absolute instruments used at land stations of the *Carnegie*, and dip circle No. 202, thus providing 2 complete outfits. The party, with headquarters at Solomons Island, made observations at 13 stations, during June 27 to July 8, 1919. These stations are distributed over a distance of about 24 miles along the west shore and throughout 17 miles approximately of the eastern shore and outlying islands. The stations are in 2 lines between 10 and 14 miles apart, and their mean position is not far from the position of swing at north latitude 38° 12′ and west longitude 76° 16′.

E. Kidson.—After the conclusion of the Australian Survey, Mr. Kidson returned to Washington and in the summer of 1915 went to England to offer his services to his country. Prior to entry upon military duties, he secured comparisons between the instruments of the Department and those of such English observatories as were in position to cooperate. The instrument taken for the purpose was magnetometer-inductor No. 26, which had been thoroughly compared with the instruments used as standard at

Washington. Comparisons were obtained with Kew, Greenwich, Stonyhurst, and Eskdalemuir observatories in August, September, and October 1915, war conditions preventing an inclusion of other European observatories in the series. The results of these observations are fully discussed in the special report on observatory comparisons.

W. J. Peters and D. W. Berky.—During an expedition in the summer of 1914 in the three-masted schooner *George B. Cluett* (see view 7 of Plate 5) to Hudson Bay and adjacent waters, land observations were made at Battle Harbor and points in vicinity and, as opportunity offered, at landings during the cruise. Reconnaissance observations were made also at points about the Battle Harbor station to determine the desirability of that place as a location for a magnetic observatory. The expedition left Boston on June 21, 1914, sailed from Battle Harbor for the north on July 30, and returned late in October. Stations were occupied at Bay of Islands, Newfoundland, and at Sydney, Nova Scotia, on the return to Washington, where the party arrived on November 14. The land stations occupied were as follows:

TABLE 39.

No.	Name	Date	Lat. North		Long. East	
		1914	°	′	°	′
1	*Battle Harbor*[1]	June, July, Oct.	52	16.4	304	25
2	Gull Rocks, *A, B*	July 18, Oct. 15	52	18.7	304	20
3	Boulter Rock, *A, B*	" 31	53	06.2	304	14
4	Domino	Aug. 2	53	28.4	304	14
5	Gready	" 4	53	48.2	303	35
6	Hopedale	" 9	55	27.1	299	48
7	Sangmijok	" 19	59	59.0	295	48
8	Port Burwell, *A, B*	" 21–22	60	24.8	295	08
9	Ashe Inlet, *A, B*	" 27	62	32.8	289	25
10	Erik Cove	Sep. 1	62	33.2	282	35
11	Smith Island	" 3	60	44.2	281	21
12	Mistake Bay	" 6	59	12.6	281	49
13	Eskimo Point	" 13	61	09.8	266	08
14	Coats Island	" 19	62	37.2	277	47
15	Green Island	Oct. 15	52	17.8	304	20
16	Great Island	" 17	52	17.4	304	24
17	*Bay of Islands*	Nov. 3	48	57	302	00
18	*Sydney*	" 11	46	08.8	299	48

[1] Eleven supplementary stations were established here to test for local disturbance.

The results obtained by observations on board the schooner during the cruise will be published in a subsequent volume of these *Researches*.

A. D. Power and L. L. Tanguy.—The *Carnegie* was detained in port at Buenos Aires from March 2 to December 4, 1917, because of conditions arising from the Great War. An opportunity was thus afforded for sending out members of the party to reoccupy magnetic stations of the Meteorological Service of Argentina for secular-variation data. Accordingly, Messrs. A. D. Power and L. L. Tanguy were assigned to this work by Captain Ault, and several series of expeditions were planned so as to cover all portions of the country that could be reached from the railroads. During the early part of the work Messrs. Power and Tanguy traveled together, but, as Mr. Power's services were required aboard the *Carnegie* after July 1, Mr. Tanguy completed the program alone. The Argentine government not only took a kindly interest in the work but also rendered material assistance, providing free transportation over the railway lines and on the government steamers. Magnetometer-inductor No. 25 was used; it was compared before and after the field work with the standards at the Pilar Observatory.

Table 40 shows the stations occupied.

TABLE 40.

No.	Name	Date	Lat. South	Long. East
		1917	° ′	° ′
1	Zapala	Apr. 28	38 55.2	289 56
2	Cipolletti	" 30	38 56.3	292 00
3	Chelforo	May 3	39 06.1	293 28
4	Pichi-Mahuida	" 4–5	38 50.3	295 03
5	Rio Colorado	" 8–9	38 59.5	295 54
6	Bahia Blanca	" 11	38 46.7	297 44
7	Saavedra	" 13	37 46.2	297 39
8	General La Madrid	" 15	37 15.7	298 44
9	Olavarria	" 16	36 53.8	299 40
10	Las Flores	" 18, Nov. 15	36 02.9	300 52
11	Navia	May 29–30	34 46.8	293 26
12	Buena Esperanza	" 31	34 45.8	294 45
13	San Rafael	June 2	34 36.5	291 37
14	Las Catitas	" 4	33 18.3	291 57
15	Mendoza	" 5	32 53.6	291 08
16	San Juan, *A*	" 7	31 31.0	291 27
17	San Juan, *B*	" 8	31 31.0	291 28
18	Puente del Inca	" 12	32 49.7	290 04
19	Uspallata	" 16	32 40.8	290 36
20	San Luis	" 19	33 17.8	293 38
21	Villa Mercedes	" 21	33 39.1	294 31
22	Villa Dolores	" 23	31 57.3	294 47
23	Mackenna	" 28	33 55.6	295 36
24	Rufino	" 29	34 16.2	297 16
25	Junin	" 30	34 34.4	299 03
26	Mercedes	July 2	34 40.3	300 33
27	Pergamino	" 11	33 55.1	299 25
28	Rosario	" 12	32 56.4	299 22
29	Cañada de Gomez	" 13	32 49.2	298 38
30	Leones	" 15	32 39.4	297 41
31	Villa Maria	" 17	32 24.8	296 47
32	Rio Cuarto	" 19	33 08.0	295 38
33	Villa del Rosario	" 25	31 33.1	296 28
34	Cordoba	" 30	31 25.3	295 48
35	La Madrid	Aug. 1	27 39.3	294 44
36	Recreo	" 2	29 17.1	295 56
37	Tucuman	" 3	26 51.1	294 46
38	Talapampa	" 5–6	25 33.0	294 27
39	Salta, *A, B*	" 7–9	24 47.6	294 36
40	Embarcacion	" 11	23 13.2	295 55
41	Ledesma	" 12	23 49.5	295 13
42	Jujuy	" 14–15	24 11.4	294 43
43	La Quiaca	" 17–18	22 06.6	294 25
44	Humahuaca	" 22–23	23 12.7	294 38
45	Rosario de la Frontera	" 26	25 48.0	295 01
46	Frias	" 28	28 39.0	294 52
47	Santiago del Estero	" 29	27 46.6	299 44
48	Dean Funes	Sep. 6	30 25.6	295 39
49	Mascasin	" 7–8	31 24.0	293 01
50	Serrezuela	" 10	30 38.8	294 37
51	Chamical	" 12	30 21.5	293 42
52	Chilecito	" 15	29 10.2	292 30
53	Tinogasta	" 18	28 04.1	292 26
54	La Rioja	" 20	29 25.3	293 09

D. M. Wise.—An expedition to Sobral, Brazil, for securing special observations during the eclipse of May 29, 1919, was utilized for obtaining magnetic observations along the northeast coast of Brazil. The results of the special magnetic and atmospheric-electric work done in connection with the eclipse are given in the special report on the eclipse observations of May 29, 1919. In all, 11 stations were occupied in Brazil; 4 were approximate reoccupations of stations of the Brazilian Magnetic Commission of 1903 (see view 4 of Plate 5), and 2 were reoccupations of previous C. I. W. stations. A

twelfth station, Bridgetown, Barbados, occupied on the return to Washington, was a practical reoccupation of the station of 1905 and an exact reoccupation of the station of 1908. Mr. Wise, accompanied by Mr. A. Thomson, who had charge of the atmospheric-electric work, left Washington on March 18 and returned on August 6, 1919. The magnetic stations occupied were as follows:

TABLE 41.

No.	Name	Date	Latitude	Long. East
		1919	° ′	° ′
1	Quixada[1]	Apr. 23	4 58.4 S	321 00
2	Iguatu	" 25–26	6 22.0 S	320 43
3	Fortaleza[1]	" 29	3 43.3 S	321 30
4	Camocim	May 8	2 54.0 S	319 09
5	Sobral	" 21–June 9	3 41.6 S	319 39
6	Nova-Russas	" 12–13	4 42.5 S	319 27
7	Amarração	" 22	2 52.9 S	318 21
8	Natal[1]	" 28	5 46.7 S	324 49
9	Cabedello[1]	" 29	6 58.5 S	325 10
10	*Pernambuco*	July 3	8 03.7 S	325 07
11	*Pinheiro, A, B*	" 18	1 17.9 S	311 31
12	*Bridgetown*	" 28	13 04.8 N	300 21

[1] Approximate reoccupation of station occupied in 1903 by Brazilian Magnetic Commission.

Cruises of the Carnegie.—The work of the *Carnegie*, since publication of Volume III, will be fully discussed in Volume V of these *Researches*. During Cruises III, IV, V, and the portion of Cruise VI carried out within the interval covered by this volume, observations have been regularly made at land stations at all ports of call; in some cases these are only the usual set of land-station observations, in others they consist of extended comparisons between standard land instruments of the ship's equipment and the instruments used for observations at sea, again, others are elaborate comparisons with magnetic observatories. Only the results obtained by the standard instruments in the usual set of land observations are published here.

During Cruise III, June to October 1914, land stations were established at Hammerfest, Norway, and on the islands in the immediate vicinity, at Reykjavik, Iceland, and at Greenport, Long Island. On Cruise IV the vessel started from Brooklyn, New York, in March 1915, passed through the Panama Canal, called at Honolulu, Hawaiian Islands, went northward to Dutch Harbor, Alaska, and thence made a continuous voyage lasting 89 days to Port Lyttelton, New Zealand. Between December 6, 1915, and April 1, 1916, the *Carnegie* sailed eastward from Port Lyttelton, keeping in general between parallels of latitude 50° south and 60° south, called at South Georgia Island (see view 3 of Plate 7), and, after a brief stay, continued eastward until Port Lyttelton was again reached. When the land observations were completed the vessel left port on May 17, 1916, arrived at Pago Pago, Samoan Islands, on June 7, at Guam Island (see view 2 of Plate 7) on July 17, and at San Francisco, California, on September 21, 1916. After shore work and minor repairs the cruise was continued southward around Cape Horn, calling en route at Easter Island in the latter days of December and completing Cruise IV on arrival at Buenos Aires, Argentina, on March 2, 1917. Because of the war and consequent dangers to navigation the voyage home, Cruise V, was made by way of the Pacific and the Panama Canal. The *Carnegie* left Buenos Aires on December 4, 1917, passed around Cape Horn, called at Talcahuano, Chile, on January 11, and arrived at Callao, Peru, February 22, 1918. The voyage home was completed by passing through the Panama Canal, and thence to Washington by way of Newport News, where the party arrived June 10, 1918. Considerable alterations were made to the vessel during the succeeding year, after which,

in October 1919, Cruise VI was begun. Observations at Dakar, West Africa, the first port of call, were prevented by quarantine regulations then in force, and so the first land observations of the cruise were made at Buenos Aires, January 19 to February 21, 1920. The track then lay to St. Helena; Cape Town, South Africa; Colombo, Ceylon, and Fremantle, Western Australia. After a visit by the party to Watheroo Observatory in September 1920 the *Carnegie* sailed to Port Lyttelton, New Zealand, and thence to Papeete, Society Islands, where a brief stop was made, to Fanning Island, where conditions prevented a landing for observations, and to San Francisco, California, where she arrived in February 1921. The observers by whom the observations were made are given in the list on page 21.

The land stations occupied are listed in Table 42. In this connection, it should be noted that auxiliary stations in vicinity of main stations were usually established for the purpose of making instrument-comparisons, and in some cases to determine whether local disturbance existed.

TABLE 42.

Cruise	No.	Name	Date	Latitude	Long. East
				° ′	° ′
III	1	Hammerfest, Norway	July, 1914	70 40.3 N	23 40
	2	Reykjavik, Iceland	Aug.–Sep., 1914	64 10.4 N	338 05
	3	*Greenport*, Long Island	Oct., 1914	41 06.4 N	287 38
IV	1	*Colon*, Panama	Mar., 1915	9 22.0 N	280 05
	2	*Sisal* (*Honolulu Observatory*), Hawaiian Islands	May–June, 1915	21 19.2 N	201 56
	3	Dutch Harbor, Alaska	July, 1915	53 54.2 N	193 28
	4	*Christchurch*, New Zealand	Nov., 1915	43 31.8 S	172 37
	5	Edwards Point, South Georgia Island	Jan., 1916	54 18 S	323 34
	6	*Christchurch*, New Zealand	Apr.–May, 1916	43 31.8 S	172 37
	7	*Pago Pago*, Samoan Islands	June, 1916	14 16.8 S	189 20
	8	*Guam*, Ladrone Islands	July–Aug., 1916	13 26.2 N	144 39
	9	*Goat Island*, California	Sep.–Oct., 1916	37 48.7 N	237 38
	10	Cook Bay, Easter Island	Dec., 1916	27 08.0 S	250 35
	11	*Pilar*, Argentina	Mar.–Apr., 1917	30 40.1 S	296 07
V	1	*Pilar*, Argentina	Oct.–Nov., 1917	30 40.1 S	296 07
	2	*Concepcion*, Chile	Jan., 1918	36 49.6 S	286 57
	3	*Coronel*, Chile	Jan., 1918	37 01.9 S	286 51
	4	*Lima*, Peru	Feb.–Mar., 1918	12 04.3 S	282 58
	5	Cristobal, Canal Zone	May, 1918	9 20.7 N	280 06
VI	1	Florida, Argentina	Feb., 1920	34 32.1 S	301 30
	2	*Longwood*, St. Helena Island	Mar., 1920	15 56.7 S	354 19
	3	*Cape Town*, British South Africa	Apr.–May, 1920	33 56.1 S	18 29
	4	*Colombo*, Ceylon	July, 1920	6 54.2 N	79 52
	5	*Cottesloe*, Western Australia	Sep., 1920	31 59.3 S	115 44
	6	*Watheroo Observatory*, Western Australia	Sep., 1920	30 18.9 S	115 53
	7	*Christchurch*, New Zealand	Oct.–Nov., 1920	43 31.8 S	172 37
	8	*Point Fareute*, Society Islands	Dec., 1920	17 31.5 S	210 26

Observatory-Site Surveys.—Many of the stations listed in the Table of Results (pp. 30–97) were occupied in connection with special studies of various localities with a view to their possible availability as sites for the establishment of magnetic observatories. These will be discussed in detail in a subsequent volume of these *Researches*. In 1916 Mr. Wilfred C. Parkinson, having completed his work in the Pacific Islands, proceeded to Western Australia, where he was later joined by Mr. W. F. Wallis, who directed the examination of several places. The geographic requirements specified for the location were that it should be south of 28° south latitude, west of 118° east longitude, not less than 50 miles from the sea, at an altitude of not more than 1,200 feet, and reasonably accessible. The stations occupied in the course of the search for a suitable location are

indicated in Table 43; at most of the places indicated a large number of auxiliary stations were occupied to test the uniformity of magnetic distribution. The site finally selected was 12 miles west of Watheroo, where the Watheroo Observatory was established and put into operation with the beginning of the year 1919.

TABLE 43.

No.	Name	Date	Lat. South		Long. East	
		1916	°	′	°	′
1	*Perth*	June 13–15	31	58.0	115	50
2	*Albany*	" 18	35	01.3	117	55
3	*Cottesloe, A*	July, Aug., Oct., Nov.	31	59.3	115	44
4	Karamara	July 14	30	38.0	115	52
5	Eleven-Mile Dam	" 23	34	16.8	117	45
6	Wongan Hills	" 29, Sep. 9–11	30	53.6	116	43
7	Burracoppin	Aug. 29–31	31	21.0	118	33
8	Merredin	Sep. 2–4	31	28.6	118	17
9	Pindar	" 14–20	28	29	115	46
10	Tallering	Oct. 11–20	28	20.0	115	49
11	Bunbenoo	" 14–16	28	17.1	115	54
12	Warren's Flat	" 17–18	28	20.1	115	47
13	Woondenooka	" 23	28	24.5	115	29
14	Mullewa	" 24	28	32.0	115	30
15	Marchagee	Nov. 9–11	30	05.1	115	56
16	Pinjarrega	" 15–17	30	02.4	115	57
17	Watheroo	Dec. 20	30	17.8	116	03
		1917				
18	Watheroo Observatory Site	Feb. 10–13	30	18.9	115	53

After a preliminary examination of the region near Lima, Peru, by Mr. D. M. Wise, accompanied by Mr. Allen Sterling, and reported upon by Mr. Wise (see pp. 210–211), Mr. J. A. Fleming, chief of the Magnetic Survey Division of the Department, went to Peru early in 1917 and took personal supervision of the investigation. The regions examined are indicated in Table 44, which shows principal stations occupied; extended and detailed study was made of the conditions surrounding each. Views 1 and 6 of Plate 5 and view 5 of Plate 6 are typical of regions examined. A location was finally decided upon as satisfactory in the vicinity of Huancayo, where an observatory is now being constructed and will be in operation during the latter part of 1921.

TABLE 44.

No.	Name	Date	Lat. South		Long. East	
		1917	°	′	°	′
1	*Ica*[1]	Mar. 5	14	04.7	284	14
2	*Pisco*[1]	" 7	13	42.4	283	46
3	Vitor[1]	" 13–15	16	26.0	288	10
4	Hacienda Huayta[1]	" 27–28	15	29	289	35
5	*Juliaca*	" 31	15	30.0	289	51
6	*Huancayo*[1]	Apr. 11–16	12	04.5	284	46
7	Pamparca[1]	" 14–15	12	02.2	284	40
8	Huayao	" 16	12	02.8	284	39

[1] Two or more stations were occupied at each of these places to test for local disturbance.

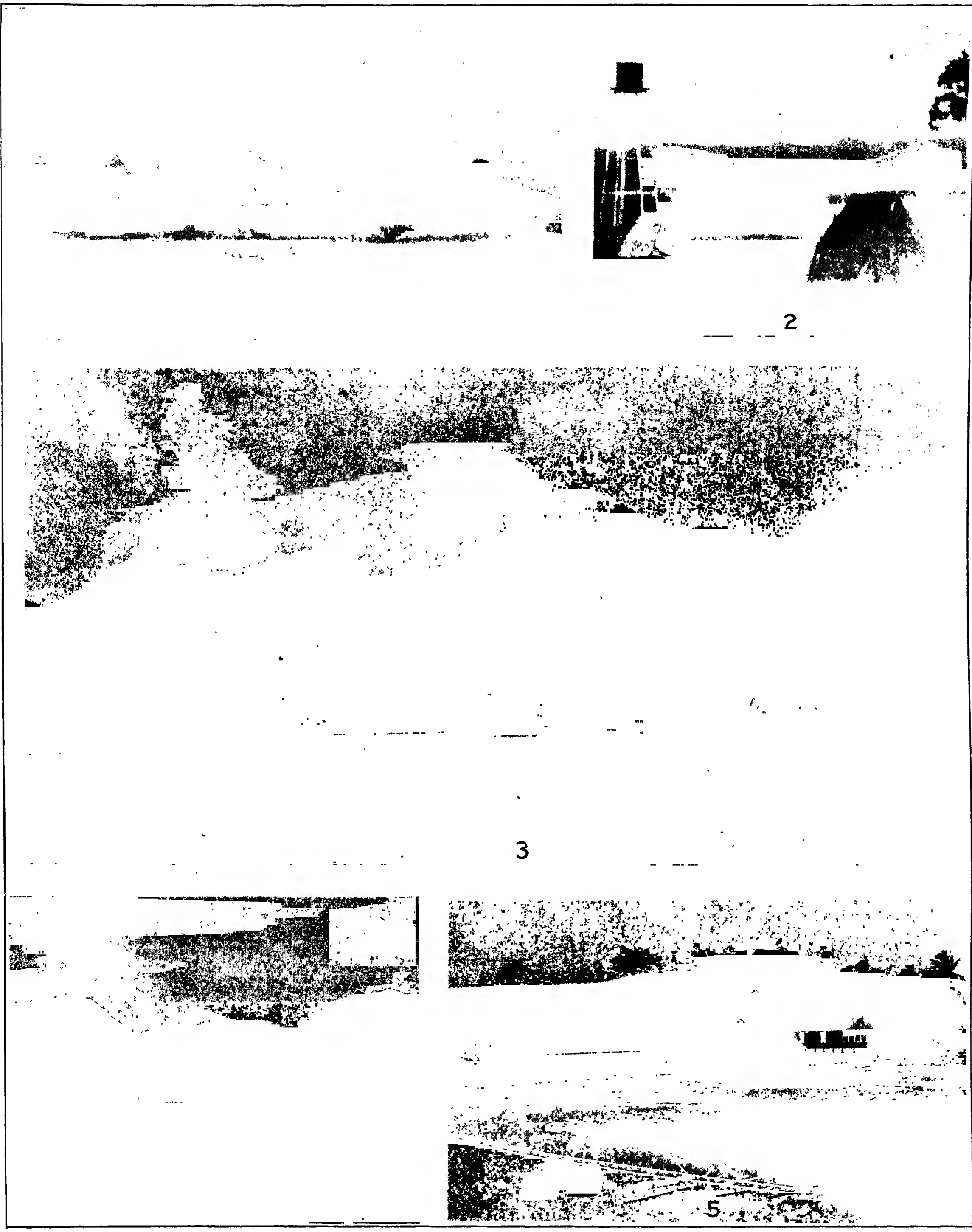
Mr. H. F. Johnston was detached from the *Carnegie* party in May 1916 while at Christchurch, New Zealand, and on his way to Washington made observations on Tahiti and adjoining islands of the Society Islands with a view to ascertaining the desirability of those islands as a site for an observatory. On arrival in California secular-variation observations were made at stations near San Francisco and near San Diego.

The study of the region about Battle Harbor on the Labrador coast has been referred to under the report of the Hudson Bay expedition of Messrs. W. J. Peters and D. W. Berky. Other studies were made by the *Carnegie* party at Guam and at Easter Island in connection with the regular work of the vessel.

Standardizing Observations.—In addition to the comparisons made at observatories in the course of field work, or on journeys to and return from the field, special arrangements have been made at other times to secure the desired correlation of standards. In June 1915 Mr. H. W. Fisk made an extended series of comparisons with the standards at Cheltenham, using magnetometer-inductor No. 26 for all three elements. This series was supplemented in January 1917 for inclination by Mr. H. R. Schmitt's observations, using the same instrument.

At the Standardizing Magnetic Observatory on the grounds of the Department in Washington, D. C., careful comparisons are made between the standard instruments and those which are to be sent out for field use. These comparisons are repeated on the return of the instruments from the field, the observations with the field instrument being in general made by the field observer so as to correct for any personal equation arising from the manner of using the instrument, while the observations with the standard are made as nearly simultaneously as possible by another observer. In a similar way comparisons have been made with instruments of other organizations. Magnetometer No. 40 of the United States Coast and Geodetic Survey was compared in March 1918 by Mr. W. W. Merrymon and members of the Department staff; in November and December 1915 Mr. C. A. French of the Dominion Observatory, Canada, and Mr. W. E. W. Jackson of the Meteorological Service of Canada secured comparisons, with the assistance of the Department staff, between instruments of their respective organizations and those of the Department.

Eclipse Parties.—Observers who are in the field have made prescribed special observations, and references to these are found in their respective field reports. Parties organized especially for work during eclipses have in most cases secured regular station observations at one or more points in addition to the special eclipse observations, which are usually confined to eye-readings of declination. At the time of the eclipse of June 8, 1918, observations of this kind were obtained by Dr. L. A. Bauer at Corona, Colorado; by Mr. W. J. Peters at Lake Moraine, Colorado; by Messrs. H. W. Fisk and C. C. Ennis at Goldendale, Washington; by Dr. C. W. Hewlett at Brewton, Alabama; by Professor H. M. Kuehne of the University of Texas at a station near Austin, Texas; and by Professor G. L. Hosmer of the Massachusetts Institute of Technology, at Woburn, near Boston, Massachusetts. At Lakin, Kansas, a magnetograph outfit was set up and kept in operation for about one month by Mr. D. M. Wise. During the eclipse of May 29, 1919, special observations with magnetograph installations were made at Sobral, Brazil, by Mr. Wise, and at Huayao, Peru, by Dr. H. M. W. Edmonds. Dr. L. A. Bauer, accompanied by Mr. H. F. Johnston, made a special series of observations for the three elements at Cape Palmas, Liberia, and at supplementary stations in the neighborhood. Special declination series during the eclipse of May 29, 1919, were also obtained by Mr. F. Brown at Campo, Cameroun, by Mr. C. R. Duvall at Washington, D. C., and by A. Sterling at Puerto Deseado, Argentina (see p. 200).



Typical Views of Magnetic Expeditions in Islands of the Atlantic and Pacific Oceans.

1. Walpole Island, Pacific Ocean.
2. Guam Island, Pacific Ocean.
3. Edwards Point, South Georgia Island, Atlantic Ocean.
4. Teneriffe Island, Atlantic Ocean.
5. Makambo Island, Pacific Ocean.

DESCRIPTIONS OF STATIONS.

As stated in the previous volumes, one of the chief difficulties experienced by the observers of the Department of Terrestrial Magnetism, in the reoccupation of old stations for secular-variation data, has been the lack of necessary information to permit precise recovery of the point where the previous observations were made. Owing to the frequent occurrence of local disturbance, it may readily happen that erroneous secular-variation data will result from non-recovery of exact station. Accordingly, the observers of the Department are instructed to furnish as complete descriptions as possible of stations occupied, especially of such as give promise of future availability. Information additional to that contained in the published descriptions or copies of station-sketches or of photographs of surroundings will gladly be furnished those who are interested in the reoccupation of any of the stations.

The descriptions are given in alphabetical order under the same geographical divisions adopted in the Table of Results. The general form followed in the descriptions is: Name of station, year when occupied, general location, detailed location, distances and references to surrounding objects, manner of marking, and finally the true bearings of prominent objects likely to be of permanent character. All bearings, unless specifically stated otherwise, are true ones, and are reckoned continuously from 0° to 360°, in the direction, south, west, north, east. For some expeditions, owing to the absence of surrounding objects to which reference could be made and to the nature of the country traversed, the descriptions of stations naturally could not be made very full or precise; for some stations the data were necessarily so meager that worth-while descriptions could not be made up at all. When no mention is made of marking of station, it is to be understood that the station was either not marked at all or not in a permanent manner. For those stations which could properly be designated under more than one name, or which had several names locally, appropriate cross-references have been made.

The majority of the measured distances were made originally in the English system; however, the distances obtained by conversion into the metric system are also given, but inclosed in parentheses, so as to show that they are converted figures. The following rules have been adopted in the conversions: Distances given to 0.01 foot are converted to the nearest 0.001 meter, 0.1 foot to the nearest 0.01 meter, 1 foot to the nearest 0.1 meter, estimated feet or yards to nearest meter, estimated fraction of a mile to nearest 0.1 kilometer, estimations of more than a mile to nearest kilometer. Short and important reference distances, when measured accurately, have been converted into nearest 0.1 centimeter; such measurements, however, as, for example, dimensions of marking-stones, etc., which are not of great importance, have been converted to the nearest centimeter. If a distance is given immediately preceding an azimuth of a mark, it is to be interpreted as distance from the magnetic station to the mark; it is in general estimated.

AFRICA.

ABYSSINIA.

Addis Abeba, British Legation, 1914.—On grounds of British Legation, in field south of Legation office and east of drive leading from main entrance gate to Legation buildings, about 60 meters paced from east fence line of drive, measured from point in fence about 40 meters paced south of gate opening into field from drive; marked by tent peg driven flush with surface of ground. True bearings: lightning-rod on roof of dwelling of Ras Abata, 39° 27′.7; cupola on King's palace, 75° 58′.8; flagstaff at British Legation, 209° 26′.1.

Addis Abeba, Catholic Mission, 1918.—On land belonging to Catholic Mission, just west of site of new church, just inside entrance to sisters' mission school, 25 meters south of gate and 2.5 meters west of row of eucalyptus trees separating the two properties; marked by tent stake driven flush with surface. True bearings: tall eucalyptus tree in front of white house, 58° 54′.5; south corner of stone school building, 93°48′.5.

Adi Musseno, 1914.—Beside trail from Dessié to Makalle, about 1 kilometer north of native village of Adi Musseno, in valley extending approximately north and south, on both sides of which are towering cliffs of yellow rock, and through which runs a good stream of water, flowing northward.

Afdem, 1914.—On level plain east of railroad station, about 150 meters paced from east rail of track, and about 90 meters paced east of east corner of small wooden building used as lodgings for travelers; marked by tent peg driven flush with surface of ground. True bearings: north side of railroad water-tank, 74° 01′.8; highest mountain peak to westward, 103° 30′.0; highest mountain peak to southeastward, 315° 10′.4.

Aicha, 1914.—On level sandy plain north of railroad track, about 185 meters paced from north rail, about 235 meters paced almost due north of railroad water-tank, and in line with center of water-tank and northeast end of ridge of roof of railway restaurant; marked by tent peg driven flush with surface of ground. True bearings: west corner of small stone house just north of railroad shops, 19° 25′.5; highest mountain peak to southeastward, 325° 58′.1; west side of railroad water-tank, 357° 00′.5.

Angowa, 1914.—In district called Angowa by natives, beside trail from Ankober to Dessié, in bare open country partly shut in by ranges of hills, about half a day's travel by mule from nearest village to westward called Sesber, where chief of district resides, according to statements of natives.

Antorkia, 1914.—On trail between Ankober and Dessié, in district called Antorkia by natives, said to be about 15 miles (24 km.) south of village of Dagaga, site of market and residence of chief of district, in rough mountainous country, at point from which no habitations are visible.

Balla, 1914.—On trail from Dessié to Makalle, 48 hours by mule caravan from Dessié, about 1 kilometer west of village of Balla, on east side of ravine containing some large trees and a little water in pools. True bearings: tip of pyramidal mountain, 212° 19′.4; double tree trunk, about one-third kilometer, 290° 45′.5.

Dessié, 1914.—On piece of grazing land west of church and northwest of dwelling of King Mikael, on sloping land facing church and dwelling, and about 50 meters southeast of group of native huts. True bearings: southwest corner of Italian commercial museum, 194° 47′.3; foot of flagstaff in rear of commercial museum,

AFRICA.

ABYSSINIA—*concluded*.

Dessie, 1914—continued.
208° 19′.1; cross on church, 261° 21′.1; pointed post on top of King Mikael's house, 312° 27′.3.

Dire Daoua, 1914.—At west end of Dire Daoua, near hospital buildings, in open space southeast of hospital, 28.2 meters south of draining ditch and 44.0 meters north of tree; marked by wooden peg driven flush with surface of ground. True bearings: southwest corner of disinfecting house of hospital, 104° 07′.5; pointed roof post, 203° 13′.1; cross on treasury chapel, 252° 34′.0.

Gimbaro-Mariam, 1914.—On low rocky hill about one-third kilometer southeast of village of Gimbaro-Mariam, about 8 miles (13 km.) east of town of Liche. True bearing: double trunk of small tree on ridge, about 1 mile (1.6 km.), 79° 32′.0.

Goolaba, 1914.—On trail between Addis Abeba and Ankober, approximately halfway between the two, 17½ hours by mule caravan from Addis Abeba, in open country, at place called Goolaba by natives, at distances of half mile (0.8 kilometer) or more from several groups of native huts.

Hawash, 1914.—On level plain about 200 meters west of town, and about 60 meters paced west by south of prominent tree stump; marked by tent peg driven flush with surface of ground, above which was heaped a pile of stones. True bearings: top of highest mountain peak to westward (Mt. Fantahli), 87° 34′.2; flagpole on Greek hotel, 258° 46′.7; south side of railroad water-tank, 273° 48′.4; top point of Mt. Gorguta, 279° 18′.4.

Makalle, 1914.—On piece of pasture land just north of town of Makalle, and about 100 meters west of small stream of water running from town. True bearings: mountain peak, about 3 kilometers, 173° 14′.7; southwest corner of stone house, about three-fourths kilometer, 307° 11′.7; southwest corner of chief's house, of white plaster, 337° 40′.9.

Sedua, 1914.—On trail between Makalle and Adigrat, about 28 kilometers south of Adigrat, at place called Sedua by natives, on small level space beside stream, apparently regular camping place for caravans.

Ula Ula, 1914.—Northwest of railroad track and opposite perpendicular bluff about 50 meters high, running parallel to and east of track, about 166 meters paced from west rail of track, measured in line with Mount Kuyu which is practically at right angles to track, 42 meters northeast of a tree, and 74 meters east by north of another tree; marked by tent peg driven flush with ground. True bearings: highest point on Mount Karansabili, 60° 29′.3; top of Mount Fantahli, 208° 48′.7; tip of Mount Kuyu, 300° 44′.1.

Waldea, 1914.—On trail from Dessié to Makalle, about 2 kilometers north of village of Waldea, and about 100 meters south of small hamlet consisting of a dozen or more native huts perched on two neighboring hills.

ANGLO-EGYPTIAN SUDAN.

Abiat, Darfur, 1917.—In intrenchment formerly occupied by British, between two villages about 1 mile (1.6 km.) apart, in deep valley about 9 miles (14 km.) long from north to south and 5 miles (8 kilometers) from east to west with an outlet between hills to southeast, in northwest corner of intrenchment, in northwest corner of rest-house inclosure, formed by a thorn-brush barrier, 4 meters south of main trench, and 20 meters

AFRICA.

ANGLO-EGYPTIAN SUDAN—*continued.*

Abiat, Darfur, 1917—contiuued.
east of trench on west side of intrenchment; marked by tent stake driven flush with ground. True bearing: peak of native hut in village to south, 7° 47′.6.

Abu Hamed, Berber, 1918.—On right bank of Nile, almost due south of railroad station, south of vegetable garden in hollow which is across street from and south of residence of district engineer, a British government official, near small landing place, in line with south mud wall around residence of an Egyptian and 31 meters southeast of its southeast corner, and 3.4 meters from edge of bank; marked by wooden peg driven flush with surface of ground. True bearings: minaret on mosque across railroad track, 172° 10′.9; telegraph pole across bend in river, 306° 08′.0.

Asserni, Darfur, 1917.—About 1.5 miles (2.4 km.) north of village, near river, 70 meters south of several large trees, and about 150 meters from river bank.

Atbara, Berber, 1918.—Close reoccupation of Egyptian survey magnetic station of 1911, in desert on east side of railway, east of military rest-house, southeast of hospital, nearly north of mamur's office, and close to southeast corner of native burial ground; marked by rough natural stone projecting 15 centimeters above surface. True bearings: minaret on mosque, 18° 04′.4; northwest corner of mamur's office, 26° 37′.2; flagpole in front of general headquarters office of Sudan government railways, 77° 14′.7; northeast corner of military rest-house, 89° 48′.6; southwest corner of railroad hospital, 131° 58′.9.

Bor, Mongalla, 1918.—On right bank of Nile, southeast of village and government buildings, 102 meters southeast of wire fence surrounding inspector's residence, and 60 meters east-southeast of eastmost corner of garden in inspector's compound; marked by natural rough stone projecting 10 centimeters above surface. True bearing: pinnacle on eastmost gable of eastmost of the Egyptian effendis' houses, 194° 47′.1.

Camp August 22, Darfur, 1917.—On trail from Abeché to Kebkebia, about 10 miles (16 km.) west of khor which was said to form boundary between Dar Massalit and Darfur, east of pass between hills overlooking flat plain, on second khor east of pass, near its junction with smaller khor from east where it is cut up into numerous channels around rocky islands, about 1 kilometer north of junction of the two khors, 100 meters east of bank of larger one, and 35 meters north of trail on sandy soil.

Dam Gamad, Kordofan, 1917.—On trail to El Nahud, in cultivated country containing many tebeldi trees, outside of and 2 meters northeast of northeast corner of thorn-brush barrier of rest-house inclosure; marked by tent peg driven flush with ground. True bearing: tebeldi tree just south of gate of encampment, 20° 55′.2.

Djenené, Darfur, 1917.—In rest-house compound occupying top of low sandy hill, the second rise going south from market along path to wells, 300 meters south of market, and about half mile (0.8 km.) east of sultan's residence, at a point 10 meters west of path and 20 meters southeast of crown of hill which is occupied by straw huts; marked by pile of natural stones taken from surface of sand within inclosure. True bearing: sharpest rocky peak appearing over near-by hills, 277° 27′.4.

Dudieh, Kordofan, 1917.—In center of traveled road to El Obeid, nearly in front of ruined rest-houses, about 170 meters west of point where telegraph-line crosses road, and about 100 meters north of telegraph-line.

AFRICA.

ANGLO-EGYPTIAN SUDAN—*continued.*

Dudieh, Kordofan, 1917—continued.
True bearing: second telegraph-pole south of road, 285° 41′.2.

El Dueim, White Nile, 1918.—Practical reoccupation of Egyptian survey station, on west bank of White Nile about 200 meters south of Nile gages, on open ground, 20 meters from high-water line, east of hospital, and 120 paces southeast of southeast corner of mud-walled compound; marked by small natural stone left level with surface of ground. True bearings: flagpole on muderia, 33° 58′.8; base of pole carrying weather vane, near hospital, 105° 38′.4.

El-Fasher, Darfur, 1917.—West of road past barracks, and 250 paces west of outer mud wall of barracks, residence of Sultan Ali Dinar; marked by irregular-shaped granite stone buried flush with sand. True bearings: ornament on top of large white dome, tomb of Sultan Zakaria, ancestor of Ali Dinar, 198° 16′.2; triangulation point on Jebel Haluf, 214° 33′.7; first joint above ground of east wireless pole, 243° 28′.2.

Elga, Darfur, 1917.—About 1 mile (1.6 km.) north of village of Elga, near junction of two wadis, on highest part of small bluff the southern face of which is about 5 meters high, about 130 meters east of junction of stream beds, and 10 meters north of two trees standing on edge of bluff; marked by tent peg.

El Galhak, Upper Nile, 1918.—On east bank of Nile, on raised path leading from river to village, 3 meters from high-water line, and 20 meters northwest of large spreading tree; marked by stake. True bearing: short perpendicular edge of rock on western end of Jebel Ahmad Agha, 357° 46′.8.

El Getaineh, White Nile, 1918.—On east bank of Nile, near edge of village of El Getaineh, and 75 meters east of highest Nile gage which records a height of 17 meters; marked by tent peg.

El Nahud, Kordofan, 1917.—East of local administration offices, inspector's residence and rest-houses, on slight mound of sand and earth just north of small shallow pond, 68 meters north of tree on southeastern edge of pond; marked by dressed sandstone monument with beveled edges, with top inscribed C. I. W. 1917, projecting about 10 centimeters above surface. True bearing: telegraph pole appearing just to right of two tebeldi trees, about half mile (0.8 km.), 240° 44′.3.

El Obeid, Kordofan, 1917.—Practical reoccupation of Egyptian magnetic survey station of 1913, on parade ground between muderia and zabtia, 120 meters north of wire entanglements surrounding residences of British officials and muderia, and 78.4 meters northwest of large lone thorn tree; marked by rough natural stone buried level with surface of sand. True bearings: ostrich egg on mosque, 76° 28′.5; southwest corner of mamur's office, 141° 50′.6; northwest corner of railroad station, 241° 45′.6; wireless mast, 336° 29′.6; southeast corner of gothic tower on muderia, 348° 13′.6.

Gedaref, Kassala, 1918.—On rocky hill east of village occupied as army post, southeast of military hospital and northeast of officers' residences, about 50 paces southeast of crown of hill, on southern edge of square cleared area, in line with north face of kind of tennis court, and 165 meters east of its northeast corner; marked by stake driven flush with ground. True bearings: pinnacle on east gable of commanding officer's house, 49° 27′.0; southwest corner of main part of hospital building, appearing above corrugated iron roof of veranda, 110° 54′.0.

AFRICA.

ANGLO-EGYPTIAN SUDAN—*continued.*

Golietta, White Nile, 1918.—On east bank of White Nile, 10 miles (16 kilometers) above Jebelain, 40 meters east of landing place of Shilluk village of 10 huts, called Golietta; marked by tent peg.

Jebel Hella, Darfur, 1917.—On sand-dunes east of village 20 meters northeast of largest, temporary, corn-stalk house; marked by tent peg. True bearing: chimney-like rock nearly as high as plateau extending along northern horizon, 195° 27′.0.

Kassala, Kassala, 1918.—On western edge of military reservation, directly west of fort, nearly in line with row of trees on south side of street running west from boundary of reservation, and 9 meters east of large drainage ditch which parallels main road and runs outside line of trees; marked by rectangular undressed block of granite about 10 by 25 by 30 centimeters, buried just underneath surface of sand. True bearings: flagpole in fort, 274° 06′.4; lightning rod on old chimney, 276° 47′.3; crevasse near top of dome in largest peak of Jebel Kassala, 328° 09′.7.

Kebkebia, Darfur, 1917.—Southwest of west entrance to post, between road running southwest and straw inclosure, about 150 meters east of market, 18 meters southeast of center of road, and 20 meters from straw inclosure containing a straw hut; marked by irregular natural stone projecting 5 centimeters above surface. True bearing: minaret on tower of mosque, 218° 08′.1.

Khartum, Khartum, 1917.—Close reoccupation of Egyptian magnetic survey station of 1911 and about 50 meters from station of 1914, on open desert east of town and southwest of fort, near old rifle range, south of new ranges, 51.1 meters northeast of square cement block with characters on top face signifying 800, just visible above surface of ground, marking 800-yard firing-point on old range; marked by rough natural stone left projecting slightly above surface. True bearings: center of 800-yard stone, 67° 17′.6; north spire of mosque, 109° 24′.6; central and tallest flagpole on palace, 130° 24′.4; flagpole on Egyptian army military prison, 169° 22′.9; smoke-stack of pumping station, 219° 15′.1.

Kilometer 285, Bahr el Zeraf, Upper Nile, 1918.—On high dredged-up bank of refuse and sand surrounded by lakes and bogs, at Bahr el Zeraf end of "new cut" or canal dug by Egyptian Irrigation Department for the purpose of drawing water into Bahr el Zeraf from Bahr el Gebel, about 200 meters northeast of kilometer mark 285 on same bank. True bearings: steel pole marking actual entrance to canal, about half kilometer across lake-like bahr, 23° 41′.0; steel pipe supporting plate numbered 285, 39° 53′.1.

Kodok, Upper Nile, 1918.—Practical reoccupation of Egyptian survey station of 1912, on left bank of White Nile, on edge of open grassy plain covered with flood water, 300 meters north of house formerly occupied by governor; marked by irregular piece of old brick wall buried so that its top surface is 2 centimeters below ground. True bearing: north corner of governor's house, 3° 24′.0.

Kosti, White Nile, 1917.—On open plain about 1 kilometer west of Nile and about 1 kilometer southeast of the Merkis, northeast of residences of railroad officials and north of straw "tukls," on point No. 2 of Kosti town survey; marked by a 2-inch (5 centimeter) "T" section steel bar 1 meter long, driven through the center of a steel plate about 10 cm. square, bar extending 50 cm. above surface. True bearings: pinnacle on east gable of inspector's house near river, 165° 30′.0; railroad semaphore signal, 207° 41′.0.

Malakal, Upper Nile, 1918.—On right bank of Nile River, at upper Nile station of Egyptian Irrigation Department, north of Province headquarters and residences and offices of irrigation department, at north corner of additional plot of land northwest of former boundary of irrigation department; marked by a granite post 8 by 25 centimeters, extending 75 centimeters above surface of ground. True bearing: granite post marking former boundary of property, similar to station mark, 332° 38′.1.

Markib, Kordofan, 1917.—About 300 meters north of road to El Obeid, in small village composed of 5 huts, about 2 miles (3 km.) southwest of large village of Markib.

Melut, Upper Nile, 1918. On north bank of Nile, where river flows west for several miles, south of road running east from village, about halfway between post-office and Sudan United Mission buildings, 40 paces north of river bank and 40 paces south of road; marked by tent peg. True bearings: flagpole of mamur's office, 82° 14′.5; residence at mission, 261° 28′.5.

Mogatta, Kassala, 1918.—About 1.5 miles (2.4 kilometers) from ford at Atbara River, about 40 meters west of thorn-bush fence of Mogatta stone rest-house, and 27 meters northwest of ruined stone storage place for durra, 1.5 meters in diameter with walls nearly 1 meter high; marked by tent stake driven flush with ground.

Mongalla, Mongalla, 1918.—On bushy ground between official residences and lagoon, southwest of governor's residence, east-southeast of pump-house, and 85 meters south of pipe-line leading to stand pipe; marked by cement building block left with its face barely above surface of ground. True bearing: center of ornament on roof of British officers' mess, 206° 22′.8.

Musmar, Berber, 1918.—About 326 meters north of west end of railroad tangent at Musmar station, in small draw or hollow just west of knoll covered with outcropping white quartz; marked by dark flint stone projecting 10 centimeters above surface of sand. True bearings: sixth telegraph pole west of west semaphore, 51° 43′.9; center point of tile roof on signal tower, 296° 11′.4; east edge of railroad water-tank, 342° 28′.8.

Nyemeir, Kordofan, 1917.—Northeast of village, outside of and northwest of west corner of rest-house compound, 5 meters east of large thorn tree; marked by tent peg.

Om, Darfur, 1917.—About 1 mile (1.6 km.) north of large pool of salt water at base of rock cliff, and some native salt workings, on north bank of Wadi Om, about 200 meters up-stream from where trail to El-Fasher crosses wadi.

Port Sudan, Red Sea, 1914, 1918.—Stations of 1914 and 1918 are identical, and very near that of 1911. About 2 kilometers north of Port Sudan Harbor, 65 meters south-southwest of small frame house used for storing targets, 49 meters south of sand embankment used for blocking bullets, 49 meters south-southeast of target pit, and about 34 meters west of a survey stake 2 by 4 inches (5 by 10 cm.) projecting 35 centimeters above surface, with point marked by nail; marked by wooden stake driven flush with ground, with an irregular coral stone projecting 5 centimeters above ground, 15 centimeters south of stake. True bearings: tip of large water tank, 15° 19′.8; lightning rod on smoke-stack of power station, 24° 24′.6; westmost of two navigation beacons, very high steel structures, 55° 32′.1; tip of lighthouse at entrance to harbor, 358° 31′.1.

AFRICA.

ANGLO-EGYPTIAN SUDAN—*continued.*

Rahad Sheraf, Darfur, 1917.—South of trail to El-Fasher, 40 meters southeast of southern end of pond, and 150 meters north of telegraph-line.

Renk, Upper Nile, 1918.—Close reoccupation of Captain Lyon's station of 1895, on east bank of White Nile, near ruins of mud houses of old post, about 1 mile (1.6 km.) from present post, 22 meters southeast of brick and cement pier in whose river face is imbedded the 13-meter Nile gage; marked by tent stake. True bearings: center of 13-meter Nile gage, 103° 32′; pinnacle on south gable of government grain store, 278° 36′.2.

Sennar, Blue Nile, 1917.—South of railway depot, nearly in line with northeast face of water-tank, 85.5 meters southeast of railway fence, and 61.5 meters northwest of large tree; marked by tent peg. True bearings: ladder leading to top of water-tank, 138° 00′.6; northeast corner of zabtia or district office building, 301° 47′.7; distant telegraph pole, 343° 29′.1.

Shaba, Darfur, 1917.—On trail to El-Fasher, about 3.5 miles (5.6 km.) west of village of Shaba, on western slope of second sand ridge from west, reaching up to westernmost peak of Jebel Suei, at a point 40 meters east of large solitary tree. True bearing: peak rising behind hills near wadi, capped by immense overhanging rock, 57° 34′.6.

Shambe, Bahr el Ghazal, 1918.—West of market and residence of mamur, just inside old outermost dike at west side of post, 37 meters south of Lau Road; marked by tent peg. True bearings: peak of low round hut in Denka village, 0° 29′.5; northwest veranda post of army rest-house, 231° 00′.0.

Shereik, Berber, 1918.—On desert east of railroad and south of limestone quarry, 225 meters east of main line of railroad and 45 meters northeast of nearest mud house of native village; marked by tent stake driven flush with ground. True bearings: first telegraph-pole to left of small mountain south of town, 21° 51′.2; south edge of south water tank, 108° 09′.9.

Sinkat, Red Sea, 1918.—South of village, and south of curve of khor to east, west of railroad, northwest of railroad station, and south of rest-house compound, in line with west face of westmost of two stone-walled, galvanized-iron-roofed rest-houses, and 110.2 meters south of its southwest corner; marked by a dark granite stone whose top is fairly level and nearly square, about 10 by 10 centimeters projecting 10 centimeters above surface, with lower, part much larger and very irregular in shape. True bearings: triangulation station on hill, 120° 41′.1; mosque, 167° 48′.0; pile of rocks on small-topped hill to southeast, 319° 55′.1.

Station No. 6, Berber, 1918.—Close reoccupation of Egyptian survey station of 1911, on desert, northeast of railroad track and east of depot, northeast of Gold Mining Company's storage shed and shops and nearly in line with its northwest boundary, and about 130 meters southeast of company's rest-house for British employes; marked by tent peg. True bearing: south railroad semaphore, 338° 56′.6.

Taufikia, Upper Nile, 1918.—Close reoccupation of Egyptian survey station of 1913, on right bank of Nile, 150 meters south of officers' mess, and 70 meters northeast of powder magazine; marked by tent peg. True bearings: palm on Doleb Hill, 27° 59′.3; south corner of officers' mess, 171° 52′.9.

Tongo, Upper Nile, 1918.—On left bank of White Nile, east of Catholic Mission, and east of compound of

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ANGLO-EGYPTIAN SUDAN—*concluded.*

Tongo, Upper Nile, 1918—continued.

Egyptian army transport station, in line with north face of veranda of brick rest-house erected by government for use of British officers, and 132 meters east of its northeast corner; marked by tent peg. True bearings: east gable of rest-house, 92° 05′.9; southeast corner of Catholic Mission building, 97° 18′.0.

Um Esheishat, Darfur, 1917.—On trail to El-Fasher, about 1 hour's travel west of well of Um Esheishat and 1.5 hours' travel east of Um Zeredia, near corn-stalk rest huts, 75 meters south of telegraph-line, and on north edge of clearing surrounding huts. True bearing: telegraph-pole on highest part of hill close to well of Um Zeredia, 107° 52′.4.

Um Ruaba, Kordofan, 1917.—On official grounds, over mark of Survey Department's town survey, 111.4 meters east of center of northeast face of inspector's residence, 88.6 meters east of azimuth station of town survey, in line with east gable of inspector's residence, azimuth station, and railroad well, 153.5 meters south of concrete block near south corner of officials' quarters, and 87 paces west-southwest of west corner of district office building; marked by concrete block 5 centimeters below surface of sand, with deep cross on its face. True bearings: pinnacle on west gable of inspector's residence, 101° 20′.2; east gable of mamur's residence, 140° 23′.8; concrete block, 180°; east gable of officials' quarters, 207° 11′.4; east gable of district office building, 280° 54′.9; sheers over railroad well, 296° 42′.6; telegraph-pole, 348° 58′.0.

Wad Banda, Kordofan, 1917.—On trail to El-Fasher, 100 paces east-northeast of northwest corner of compound of largest and most important rest-house nearest village of Wad Banda; marked by wooden stake.

Wadi Halfa, Berber, 1918.—East of railway station of Halfa Camp, about midway between Nile bank and foot of hills, about 300 meters south of golf links, 200 meters southeast of telegraph-line, and about 450 meters southeast of railroad tracks; marked by rectangular piece of reddish stone, whose top face is about 15 centimeters square. True bearings: railroad semaphore farthest south, 53° 10′.2; tomb of Mohamed Maayardin el Essed, 185° 28′.3; mosque in Halfa, 210° 11′.6.

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Ambriz, 1915.—In large open field northwest of main part of town, southwest of main street, on plateau about 450 meters from beach, 73.10 meters from north corner of old stone slaughter-house standing near center of field, 38.35 meters southwest of lamp-post on opposite side of street, 51.95 meters nearly south of south corner of vacant house on east side of street, and 10.85 meters nearly north of small tree. True bearings: north corner of stone slaughter-house, 117° 08′.5; signal staff at lookout tower on cliff, 133° 48′.2; west corner of warehouse near street above beach, 154° 18′.9; lamp-post across street, 252° 41′.8.

Bela Vista, 1920.—On premises of American Board Mission station at Dondi, 5 kilometers north-northeast of railway station, in low bush west of main road, 64.9 meters west of northwest corner of and in line with north side of south mission residence; to be marked by brick column. True bearings: gable of porch of most northern of 3 houses at girls' school, 3 kilometers, 147° 04′.0; south gable of school, 184° 05′.0; north side of chimney of mission residence, about 80 meters, 228° 31′.0; northwest corner of south residence, 262° 40′.9.

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ANGOLA—*continued.*

Belmonte, Bie, 1920.—In open "Place" on east side of settlement, on line between post-office and courthouse, at a point about 100 meters northeast of post-office, 82.00 meters southwest of southwest corner of courthouse, 9 paces north of path, and 33.00 and 38.95 meters respectively northeast of two eucalyptus trees. True bearings: east eucalyptus tree, 14° 58′; west eucalyptus tree, 37° 05′; east gable of post-office, 69° 49′.1; southwest corner of courthouse, 249° 00′.3.

Benguela, 1915, 1920.—Station of 1920 is close reoccupation of C. I. W. station of 1915; it is on southeast side of Municipal Square, in front of bank building, 36.94 meters east of electric-light pole south of fountain, 30.84 meters and 51.11 meters respectively from curbs on east and south sides of square. True bearings: ornament over center door of Municipal Building, about 100 meters, 49° 29′.6; telegraph pole at corner of red compound, 0.4 kilometer, 121° 36′.1; center of figure on fountain in Square, about 80 meters, 136° 59′.0; flagpole on bank, about 50 meters, 281° 54′.2.

Boma, 1920.—At English Mission station about 12 kilometers east of Moxico, near center of strip of clearing used as garden south of main road, about 90 meters east of school and south of mission residences, 39.8 meters south of large tree at north end of garden, and 60.1 meters south of southeast corner of mud wall around center mission residence; marked by pillar of white bricks, with base 60 centimeters square and 20 centimeters high with upper part 35 centimeters square and 30 centimeters high. True bearings: south end of roof of school, 90° 54′.6; east end of center of three residences, 144° 18′.7; base of large tree in garden, 159° 03′.8; east end of roof of east mission residence, 183° 07′.8; straight tree in valley, 1.5 kilometers, 352° 48′.0.

Bumba, 1920.—At abandoned Portuguese government post, in open space near residences, 18.60 meters southwest of southwest corner post of larger building, and 16.50 meters west of southwest corner post and in line with south veranda posts of smaller building. True bearings: southwest corner post of larger building, 205° 45′.1; northwest corner post of smaller building, 256° 25′.9; southwest corner post of smaller building, 290° 18′.3.

Cabinda, Cabinda, 1915, 1916.—Station of 1915 is on property of Hatton and Cookson, 56.40 meters south-southwest of south corner of Chief Agent Royle's house, about 12 meters southeast of tree-lined path to hospital, 19.05 meters south of coconut-palm beside tree-lined path, 25.30 meters from northern one of two oil-palms nearly in line with chief agent's house, 10.93 meters northwest of coconut-palm; marked by projecting point of stone planted in sandy soil. True bearings: south corner of chief agent's house, 204° 57′.6; flagpole over tiled roof, 349° 25′.7.

Station of 1916 is on beach, about 200 yards (183 meters) east of wharf, and 13 paces west of center of continuation of avenue of banana plants leading down from office and factory of Portuguese Congo Company; marked by tent peg. True bearings: base of government flagpole, 11° 54′.7; flagpole on Hatton and Cookson, Ltd., near wharf, 104° 35′.1; flagpole of English mission, 338° 32′.2.

Cabiri, 1915.—Approximate reoccupation of U. S. Coast and Geodetic Survey station of 1889, on top of hill south of railway and southwest of railway depot, about 100 meters south of state office building, and 19.81 meters northwest and 18.37 meters north-northwest respectively from paupai trees, the only trees on the hilltop; marked by cross on top of block made of stone and

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ANGOLA—*continued.*

Cabiri, 1915—continued.
lime mortar, 32 centimeters square and buried flush with ground. True bearings: monument on hillside, 32° 18′.1; tangent to outer rail on railway curve, 129° 51′.3.

Calengo, 1920.—In cleared space around government rest-house, 2 days' march west of Dilolo, near edge of manioc plantation, 24.80 meters northeast of northeast corner-post of rest-house, and 17.50 meters north of northwest corner post of most northern native house. True bearings: northwest post of native house, 18° 16′.4; southeast post of rest-house, 48° 52′.2; northeast post of rest-house, 64° 28′.8.

Camundongo, Bie, 1920.—On premises of American Board Mission station, 12 miles (19 km.) southeast of Belmonte, 75.0 meters southwest of southwest corner of west residence compound, 24.5 meters north of northwest corner of garden wall, and 15 and 16 paces respectively from roads to south and north; marked by circular slab of rock, 0.5 meter in diameter, upon which is placed a similar rock whose top is 10 centimeters above surface of ground, and is to be covered with cement, and inscribed "C. I. W., 1920." True bearings: southwest corner of residence compound, 244° 32′.5; north edge of church, 400 meters, 258° 42′.6; south end of roof of printing office, 280° 09′.7; northwest corner of wall of compound, 347° 44′.1; left end of large native house across valley, 1 kilometer, 354° 12′.7.

Cassoalala, 1915, 1920.—The station of 1915 was in open ground about 150 meters north of hotel, 90.50 meters east of southeast corner of top stone of culvert under railroad, 25.75 meters southwest from near side of large tree, 44.9 meters northwest from northwest corner of railway store, and 19.45 meters northeast of palm tree; marked by cross cut in top of large flat natural stone set flush with ground. True bearings: southeast corner of top stone of culvert, 83° 47′.8; north corner of railway store, 288° 50′.7; northwest gable of telegraph office, 350° 20′.7. The station of 1920 was a proximate reoccupation of station of 1915 and south of hotel and railway station, on east side of main road leading south to river, on slight elevation of ground, about 200 paces from southeast corner of railway reserve, about 80 paces south of large prominent baobab tree at bend in road, and 6.05 meters and 11.60 meters respectively from small trees on west and east sides of road. True bearings: right gable end of goods shed, 350 meters, 167° 32′.9; bottom of nearby small tree, 350° 03′.0; trunk of large tree, 2 kilometers, 353° 37′.9.

Catengue, 1915.—On waste land east of railway depot and Transvaal Hotel, about 280 meters from depot, and 30.8 meters southeast, 18.0 meters southwest, and 36.2 meters northeast respectively from large trees; marked by small wooden stake. True bearings: south gable of depot, 64° 50′.7; northeast corner of water-tank, 88° 18′.5.

Cazeze, 1920.—At farm belonging to Mr. Schau, about 25 kilometers northwest of Portuguese post of Calunga Cameia, 200 paces south of main path measured from point about 700 paces east of farm buildings, 15.6 meters west of thatched shelter over stone marking eastern extremity of base-line of trigonometrical survey of property, and 110 paces south of long mound in cultivated field. True bearings: west edge of island of trees in swamp, 0.5 kilometer, 1° 28′.9; roof over west stone of base, 1 kilometer, 79° 03′.5; top of roof over east stone of base, 265° 11′.

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Angola—*continued.*

Chabaia, 1920.—At government rest-house encampment, on main road, one day's march from Calunga Cameia to Dilolo, in line with west side of rest-house, 29.15 meters north of northwest veranda post and 24.30 meters southeast of lone tree which bears 122° 12′. True bearings: northwest veranda post of rest-house, 11° 54′.8; northeast veranda post of nearest native hut, about 30 meters, 59° 41′.7.

Chiloango, 1915.—On Hatton and Cookson's property, about 95 meters nearly north of Saunder's pillar, 28.70 meters northeast of north corner of small dwelling, 9.87 meters east of tree at north end of short row of palms, 30.70 meters northwest of palm standing near north end of lumber shed. True bearing: flagpole on Hatton and Cookson's shop, 348° 03′.1.

Chinguar, 1915.—On open veldt, about 180 meters southeast of railway depot, 4.82 meters east of path, 52.1 meters southeast of nearest native house, and 33.78 meters north of tall stump; marked by hole picked in top of natural rock projecting slightly above ground. True bearings: east gable of cottage, 110° 01′.4; west gable of magazine, 184° 39′.9.

Chissamba, Bie, 1920.—On premises of American Board Mission station, in open space between old tennis-court and two saw-pits, 54.95 meters northeast of southeast corner of mud wall of ladies' residence compound, 47.25 meters east of north side of gate in wall near northeast corner of ladies' residence, and 16.00 meters south of center of path leading east from residence; marked by brick pier 40 centimeters high, covered with cement and marked "C. I. W." True bearings: southeast corner of mud wall of ladies' residence compound, 22° 47′.8; top of north chimney of residence, 79° 30′.4; north side of gate in wall near northeast corner of residence, 93° 43′.4; southeast corner of boys' dormitory, about 60 meters, 145° 06′.8; south edge of red mud-house across valley, 2 kilometers, 291° 07′.3.

Cuanza, 1920.—At Government Post, on east bank of Cuanza River, in open space south of fort, 46.10 meters southwest of west side of entrance, 28 paces south of south edge of moat near flagstaff, 7 paces north of main road from Belmonte to Moxico, and 77 paces west of large tree, south of road. True bearings: flagstaff on southwest corner of fort, 187° 05′.7; west side of doorway of fort, 219° 15′.6; fork of large tree on main road, 257° 50′; fork of large tree on skyline, 2 kilometers, 292° 23′.0.

Cubal, 1915.—About 130 meters north of railway track, measured from east end of south siding, and 27.13 meters southeast and 32.90 meters east respectively of large trees; marked by peg. True bearings: front gable of depot, 49° 50′.8; west gable of dwelling of Señor Fernandez, 303° 07′.6; peculiar hump on distant mountain, 326° 17′.8.

Cuma, 1915.—On south side of railroad, about 180 meters south and 50 meters east of railway depot, 8.5 meters east of path, 14.65 east of small tree, 10.6 meters west of top of ant-hill, and 40.90 meters south-southwest from south corner of nearest native house; marked by large stake projecting 25 centimeters above ground. True bearings: telegraph-pole at depot, 162° 45′.7; west gable of Holland House, 222° 43′.2; center of highest mount in vicinity, 292° 55′.1.

Dilolo, 1920.—In large open space between Portuguese fort and quarters of native troops, 39.35 meters east of southeast corner post of most easterly of north row of huts and in line with their south sides, and 48.20 meters southwest of flagstaff in west "tambour" of

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Angola—*continued.*

Dilolo, 1920—continued.
fort. True bearings: northeast corner post of east hut in south row, 37° 02′.0; southeast corner post of east hut in north row, 77° 22′.3; flagstaff of fort, 247° 12′.0; top of watch-tower over entrance to fort, 272° 56′.7; south corner of fort, about 100 meters, 290° 44′.6.

Huambo, 1915, 1920.—Two stations, *A* and *B*, were occupied. Station *A* as occupied in 1920 is about 10 meters southeast of C. I. W. station *A* of 1915, on hillside about 200 meters southeast of railway station, 130 paces southeast of cross-roads and about same distance southeast of trading store opposite hotel, 10 paces west of center of main road, and 57.90 meters east-southeast of southeast corner of iron shed. True bearings: west veranda post of governor's palace, 2 kilometers, 32° 34′.6; corner of iron shed, 126° 17′.3; west corner of railway shed, 152° 30′.4; mountain with perpendicular sides, 271° 45′.8; lone mountain on plain, 303° 14′.7.

Station *B* about 1.5 kilometers east of railway station, north of railway, on slope in scrub north of bungalow of resident engineer of railway company, 10 paces east of footpath at point 75 paces north of garden fence; to be permanently marked by cement pier. True bearings: near gable of inspector's house, 57° 04′.0; center of mass of red rock, 10 kilometers, 101° 21′.0; near gable of engineer's bungalow, about 100 meters, 337° 02′.2.

Kavungo, 1920.—Two stations designated *A* and *B* were occupied. Station *A* is at Portuguese Government Post, on open ground south of flagstaff, 21.40 meters south of southeast corner post and in line with east line of posts of store, 16.20 meters north of west corner of bridge over old moat, 16.05 meters south of marking stone of Barotse Mission of 1914, and 15.10 meters south of flagstaff. True bearings: northwest post of most northerly of west line of native huts, 200 meters, 46° 15′.1; near gable end of iron-roofed building, 67 paces, 104° 30′.8; southwest corner post of residence, 80 meters, 138° 25′.0; southeast corner post of store, 175° 08′.2; flagstaff, 177° 14′.3.

Station *B* is about 1 kilometer west-northwest of station *A*, on large open space west of English Mission station, north of main path to Dilolo, 50.55 meters north of northwest corner post of cactus hedge around compound on south side of main path, 27.00 meters southwest of northwest corner of stables, and 20 paces east of a large ant-hill. True bearings: west edge of goat-house, 60 meters, 109° 20′.6; large tree near corner of hedge, 100 paces, 196° 19′.6; northwest corner of stables, 217° 29′.2; southwest veranda post of mission residence, 70 meters, 274° 40′.3; northwest corner post in cactus hedge of compound, 338° 18′.5.

Loanda, 1914, 1915, 1916, 1920.—On property of American Mission, near edge of cliff overlooking railway, 123.90 meters northwest of northwest corner of inclosure around Woman's Foreign Missionary Society school, 67.90 meters nearly north of northeast corner of oldest mission building, 24.43 meters north of northwest corner of concrete veranda on west side of most northerly of mission buildings, and 4.62 meters west of extension of west edge of this veranda; marked by cross cut in top of cement block, 20 by 25 centimeters, with top face lettered C. I. W. 1915 and set so as to project 6 centimeters above surface of ground. True bearings: signal staff at Observatory, 2 kilometers, 89° 41′.3; flagstaff at fort, 2 kilometers, 114° 15′.7; chimney stack at gas-works, 3 kilometers, 217° 56′.7; north gable end of church, 334° 49′.9.

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ANGOLA—*continued.*

Loanda Island, 1915.—At extremity of small bay about 650 meters northeast of coaling station, about 100 meters north of point of small sand spit and about 14 meters from high-tide line; marked by wooden stake. True bearings: spire on municipal building, 2° 29′.5; flagpole on fort, 38° 40′.8; finial on coaling station, 44° 45′.9; Loanda Lighthouse on mainland, 250° 56′.0.

Loanda, João Capello Observatory, 1920.—Observations were made in absolute house of Observatory near governor's palace; station *A* is on north end of large pier and is Observatory station for inclination; station *B* is small raised platform near center of large pier and 25 cm. north of station *C* on same pier, *C* being Observatory station for declination and horizontal intensity. True bearing supplied by Obseravtory authorities; west corner of Fort Miguel for either *C* or *B*, 175° 51′.

Lobito, 1915, 1920.—Two stations were occupied. Station *A* is close reoccupation of C. I. W. station of 1915, on marsh-land at southwest shore of Lobito Bay, about halfway between native village and bridge over lagoon, 28.0 meters southwest of center of raised road to Catumbella, 39.7 meters and 57.0 meters respectively from eleventh and twelfth poles of transmission line, marked L154 and L153, and counted from transformer house at west corner of bay. True bearings: near gable end of north hut in "Model Village," 2 kilometers, 94° 07′.4; right edge of transformer house, 1,600 paces, 152° 18′.4; iron pole L154 of transmission line, 202° 43′.8; flagpole on Governor's palace, 3 kilometers, 208° 19′.8; Lobito Point Light, 6 kilometers, 223° 04′.5; lighthouse on mainland, 12 kilometers, 235° 59′.9; iron pole L153 of transmission line, 286° 34′.5.

Station *B* is about 1.5 kilometers northwest of station *A*, in southwest corner of Lobito Bay, on waste land between swamp and buildings at south end of railway reserve, 109.45 meters west of west corner of transformer house near main road, just south of junction of two paths leading south across swamp, and 10 and 12 paces respectively from paths to west and to east. True bearings: near gable end of northeast hut of "Model Village," 1 kilometer, 33° 13′.8; lighthouse on mainland, 10 kilometers, 242° 47′.9; top of west corner of transformer house, 263° 26′.6; transmission pole at causeway, about 200 meters, 312° 56′.0.

Lucala, 1915.—On top of hill south of railway station and west of Lucala River, 3.2 meters southwest of top of largest boulder on hilltop, 32.76 meters northwest and 21.75 meters northeast respectively of two large trees, 150 meters southwest of railway station, 44.50 meters and 45.60 meters respectively southwest and southeast from east and west ends of mud wall at rear of vacant house. True bearings: southwest corner of east abutment of bridge, 241° 19′.5; staff on top of highest house across river, 267° 03′.1.

Lumeje, 1920.—At rest-house encampment, near source of Lumeje River, 2 days' march west of Moxico, in middle of path, 46.45 meters west of large tree in clearing in front of rest-house, 45.8 meters west of northwest post of rest-house, and 17 paces south of blazed tree. True bearings: fork of tree in front of rest-house, 257° 45′.6; northwest post of rest-house, 264° 29′.2.

Malange, 1915, 1920.—In open square south of American Mission, 52 meters southwest of southeast corner of mission property, 33.85 meters west of northwest corner of municipal school building, and 42.02 meters northeast of northeast corner of building with barred

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ANGOLA—*continued.*

Malange, 1915, 1920—continued.
windows. True bearings: southwest corner of old mission building, about 80 meters, 160° 11′; north corner municipal school, 266° 43′; southernmost of 2 flagstaffs on governor's palace, 0.5 kilometer, 295° 05′.8.

Mossamedes, 1915, 1916.—In vicinity of British Admiralty station of 1896, southwest of cable station, in inclosed plot adjoining property of Eastern and South African Telegraph Company, at a point 89.3 meters and 79.8 meters respectively from west and south corners of that property, 66.2 meters northeast of north corner of house, and 22.75 meters from wall along street to northwest; marked by hole in top of rounded stone left nearly flush with sand. True bearings: lower section of flagpole on fort, 58° 05′.4; flagpole on railway depot, 61° 55′.4; flagpole of signal station, 95° 51′.2; Giraul Point lighthouse, 143° 23′.8; ornament on roof of cable station, 209° 01′.8.

Moxico, 1920.—At old fort on hilltop, about 2 kilometers west of governor's palace, in middle of south "tambour" of mud earthwork around fort, 26.00 meters southeast of east post of prison, and 8.05 meters southeast of nearest eucalyptus tree along southwest earthwork; to be marked by stone pillar about 1 meter high and 25 centimeters square. True bearings: flagstaff of fort, about 50 meters, 137° 42′.9; east post of prison, 158° 11′.7; south post of store, 188° 05′.5; flagstaff at governor's palace, 260° 13′.6; near veranda post of building in valley, 1 kilometer, 333° 14′.5.

Munhango, 1920.—In open space about midway between Portuguese fort and trading compound of Leite and Company, and west of native soldiers' camp, 34 paces from large tree with enamel plate marked "Leite & Co.", and which bears 39° 24′ and 40 paces from large tree at south end of road to fort which bears 234° 09′. True bearings: north end of roof of iron building at trading compound, 19° 12′.1; flagstaff at fort, about 200 meters, 215° 06′.3; right gable of residence of post, 220° 11′.0.

Mwandeje, 1920.—At government rest-house encampment, two days' march northeast of Kavungo, near middle of rest-house clearing, 33.15 meters northeast of southeast post of most southerly of three native huts, and 26.50 meters west of northwest post and in line with north veranda posts of rest-house. True bearings: southeast post of south native hut, 57° 51′.2; northwest corner post of rest-house, 285° 02′.2; southwest corner post of rest-house, 308° 25′.9.

Novo Redondo, 1915.—On top of ridge nearly east of landing pier, about 180 meters northwest of large commercial house on hill on road from custom-house, and about same distance southeast of light on ruins of old fort on point of ridge. True bearings: light on ruins of old fort, 165° 46′.6; center point on house across ravine, 277° 51′.5; center point on commercial house, 318° 54′.2; northeast corner of Administrator's house, 300 meters, 343° 31′.6.

Port Alexandre, 1915.—On sand hill 69.0 meters east of east corner of bunk-house and cook-house of whaling factory of "The Southern Whaling and Sealing Co." True bearings: flagpole near pier, 74° 09′.8; point light, 154° 27′.6; Point Pinda, 218° 48′.1; cross over entrance to cemetery, 333° 53′.4.

Rio Chiemba, 1920.—On grassy eastern slope on left bank of Chiemba River, about midway between Cuanza and Munhango, near scrub line along side of valley, about 300 meters southeast of ford where main path from Belmonte to Moxico crosses river, 23 paces south

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ANGOLA—*concluded.*

Rio Chiemba, 1920—continued.
of head of spring flowing northwest to ford, and 59 paces south of main path. True bearing: bottom of lone tree in valley, 2 kilometers, 55° 50′.0.

Rio Luambo, 1920.—On main path between Dilolo and Kavungo, two days' march from each place, on south side of path at a point about 450 paces along path east of bridge over Luambo River, and 59 paces west of a native path crossing main path.

St. Paul de Loanda, 1915.—See Loanda.

Tiger Bay, 1915.—On sand 62.0 meters southwest of southwest corner of schoolhouse, and 57.0 meters northwest of northwest corner of magistrate's office.

Xinguari, 1920.—About 1 kilometer north-northeast of C. I. W. station *Chinguar* of 1915, at government post, 1 kilometer east of railway station, near middle of open field, north of road to Belmonte, 61.30 meters northwest of northeast corner of captain's residence, and 6.6 meters north of lone tree. True bearings: right edge of railway water-tank, 67° 06′.5; lone tree on plain, 2 kilometers, 147° 29′.2; northeast corner of captain's residence, 318° 51′.1.

BELGIAN CONGO.

Ankoro, Tanganika, 1914.—Near edge of west bank of Lualaba River, about 85 paces northwest of point where road to state post leaves beach, 9.8 feet (3 meters) from river bank; marked by 2-inch (5. cm.) stake. True bearing: flagpole at post on hill, 50° 25′.8.

Banana, Lower Congo, 1914, 1920.—Station of 1920 is a proximate reoccupation of that of 1914; it is on waste sandy land about 140 meters north of building of Red Cross Government sanatorium, 30 paces from road along sea front, 27.95 meters southeast of coconut-palm opposite north end of sea wall, and exactly in line with west side of Red Cross building and with south side of most northerly of two residences to east; marked by stone 35 centimeters square, with top face left about 30 centimeters above ground. True bearings: center of roof of white bungalow at Pillar Point, 10 kilometers, 42° 58′.3; top of outer edge of southwest pillar of most northerly of two residences, about 120 meters, 248° 21′.9; top of church steeple, about 200 meters, 332° 57′.3; northwest veranda post of Red Cross building, 334° 36′.9; northwest boundary stone of Red Cross property, 129.15 meters, 343° 35′.9.

Bashishombe, Kasai, 1914.—On bank of Kasai River, about 100 meters south of Kasai Company Post building, and about 120 meters west of steamer landing, 1.9 meters south of path leading from landing up hill to native houses and 6.2 meters southwest of point where this path is intersected by another leading southward into forest.

Basongo, Kasai, 1914.—Southwest of state post buildings in coffee plantation, 62.25 meters south of south corner of travelers' rest-house and 38.20 meters southwest of center of west end of shed used for native church; marked by wooden stake. True bearings: weather-vane northeast of travelers' house, 198° 23′.2; south gable of state office, 222° 29′.4.

Bena Dibele, Sankuru, 1914.—In southern corner of parade ground, 2.4 meters north of citronella hedge that marks northern boundary of road leading to Silva's Magasin, southwest of general office, 47.15 meters southwest of flagpole near south corner of office, and 32.26 meters southeast of large tree near brick-sheds.

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BELGIAN CONGO—*continued.*

Bolobo, Middle Congo, 1914, 1916.—Station *A*, occupied in 1914, is on open plot of ground west of post-office and east of street which parallels beach, bounded on north and south by two parallel roads running up from beach, along sides of which are rows of oil-palm trees, 76.4 feet (23.29 meters) south 75° 21′.3 west of center of Belgian triangulation pier, 40.1 feet (12.22 meters) northeast of flagpole, and 26.2 feet (7.98 meters) south of largest and nearest of surrounding palm trees; marked by wooden stake.

In 1916 two stations, *B* and *C*, were occupied. *B* is about 50 meters north of landing-place of steamers, 10 meters west of northwest corner of market, and 8 meters east of water's edge at very high water. True bearing: oil-palm tree on beach near Baptist Mission, 160° 19′.7. *C* is the triangulation pier, west of post-office and about 50 yards (46 meters) north of factory of American Congo Company, a brick pier 45 by 45 centimeters and 1 meter high, in top of which is a bronze plate with grooves for instrument footscrew.

Bolombo, Lake Leopold II, 1914.—At post of Kasai Company, 85 meters due west of principal building, 3.9 meters west of west side of street parallel to front of building, and 1.9 meters north of north side of street meeting first at right angles, 3.3 meters northwest of Spanish bayonet plant in northern corner of these streets; marked by 5-centimeter wooden stake projecting slightly above ground. True bearing: center of middle window of principal building of post, 269° 03′.4.

Boma, Lower Congo, 1914, 1916, 1920.—Station occupied in 1920 is about 40 meters southeast of C. I. W. station of 1914 and 1916 (not available for reoccupation in 1920 because of erection of new buildings) on property of Dupont Brick Factory, northeast of factory buildings and about 180 meters south-southeast of railway station, on south side of footpath leading from railway station to river and skirting fence surrounding property, and 31.0 meters east-southeast of fence post opposite northeast corner of oven. True bearings: chimney of brick factory, 250 meters, 33° 17′.9; north edge of chimney of Monsieur Dupont's residence, 150 meters, 67° 54′.6; lamp standard on hill in front of Dutch Consulate, 0.8 kilometer, 109° 50′.2; top of tower of Governor-General's residence, 0.8 kilometer, 156° 22′.0.

Bosoko, Aruwimi, 1914.—Near shore of Aruwimi River, on triangular plot between street and fort wall at west entrance, 35.2 feet (10.73 meters) north of fort wall, 34 feet (10.4 meters) southeast of center of street, 94.2 feet (28.71 meters) northeast of tower at end of wall, and 58.9 feet (17.95 meters) southeast of tree north of street at entrance to fort. True bearings: northeast corner of tower at end of fort wall, 75° 38′.3; temporary wireless tower, 1 kilometer, 128° 06′.2; flagpole in fort bastion, 271° 19′.5.

Bukama, Tanganika, 1914.—On top of hill in rocky open space east of travelers' rest-house, 111.6 feet (34.02 meters) east of line of stones along east margin of road from trading stores to post-office, 84.5 feet (25.76 meters) northeast of large rock standing about 2 meters out of ground; marked by cross cut in top of rectangular stone, 10 by 14 inches (25 by 36 cm.) projecting 9 centimeters out of ground. True bearings: post at northeast corner of trading store, 34° 17′.7; projecting rock, 39° 26′; center post of rest-house, 98° 33′.2; flagpole at post-office, 205° 53′.2.

Chinquengue, Lower Congo, 1916.—On right bank of Congo River, about 2 miles (3 kilometers) east of town of

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BELGIAN CONGO—*continued.*

Chinquengue, Lower Congo, 1916—continued. Boma and just east of village of Chinquengue, on top of Hill 109, just north of British consulate at foot of hill, past which runs a footpath from bank of river; marked by low cement monument, about 40 centimeters square, with top lettered H. S. 1915 II. True bearings: Station V, center of south edge of Sacra Baka Island, 29° 33′.2; west point of Sacra Baka Island, 70° 21′.3; Fort IV, 96° 53′.6; triangulation mark No. 1, Hill 300, Rocca Island, 317° 13′.8.

Coquilhatville, Equateur, 1914.—In eastern end of town on state grounds, at point of junction of Ruki and Congo rivers, northwest of clubhouse, 16 paces northeast of Lemaire's pillar, and 24 paces west of large tree near northwest corner of clubhouse.

Dima, Kwango, 1914.—Northwest of Kasai Company town, about 150 meters from D'Obry astronomical pillar in town square, about 150 meters west of flagpole, 22.98 meters northwest of north corner of new passenger house, 46.15 meters west of west corner of old office; marked by large wooden stake. True bearings: cross on native chapel, 74° 24′.4; flagpole in square, 286° 45′.0; D'Obry pillar in square, 301° 43′.4.

Djoka Punda, Kasai, 1914.—In slashing near river's edge, 9.6 meters south of path from steamer beach to State Post, 9.5 meters southwest of banana palm and 6.45 meters north of large stump.

Eiclo, Kwango, 1914.—About 100 meters east of Kasai Company house, 5.15 meters south of center of pillar erected in 1909 by Commandant Willemoës D'Obry, 7.01 meters southwest of palm standing nearest to pillar, 10.9 meters north of edge of road leading down to beach, and 11.4 meters east of east edge of path leading to grave of M. Cambier; marked by wooden stake. True bearings: axis of arrow in top of pillar, 164° 26′; east corner of veranda of Kasai Company house, 80° 44′.5. (Willemoës D'Obry's pillar is of brick covered with cement with arrow in top; station, is in line with this arrow. On west side is zinc plate with latitude and longitude of place; on south side plate bearing Commandant Willemoës D'Obry's name, and date 1909.)

Elisabethville, Upper Luapula, 1914, 1920.—Station of 1920, which is close reoccupation of C. I. W. station of 1914, is on strip of built-up embankment southwest of boulevard and west of building of British Vice-Consulate office, at a point opposite second pillar of retaining wall southeast of drain from boulevard, 12.75 meters south of opening of drain, 5.80 meters west of second pillar southeast of drain, and 6.90 meters north of joint of third pillar southeast of drain. True bearings: left gable of brick house visible through tree, 0.5 kilometer, 142° 59′.4; light pole at cross-roads, 150 meters, 150° 18′.0; west corner of brickwork of secretary's house, about 30 meters, 197° 50′.8; south corner of consulate office, about 50 meters, 274° 16′.1.

Fardiala, Kasai, 1914.—South of boma of Chief Fardiala near center of strip of ground designated as street, 69.9 feet (21.31 meters) south of south corner of house for white travelers, 71.8 feet (21.88 meters) west of west corner of native house along street southeast of travelers' house, 53.8 feet (16.40 meters) northwest of north corner of nearest native dwelling on south side of street, and 35.7 feet (10.88 meters) east of palm tree on south margin of street; marked by wooden stake 10 centimeters in diameter.

Kabalo, Tanganika, 1914.—On bare plot of ground about 400 meters east of beach and railway station, southeast of intersection of two streets which pass immediately south and west respectively of dwelling of Chief Engineer Adams, 24.1 feet (7.35 meters) and 16.5 feet (5.03 meters) south and east respectively of pineapple hedges bordering these streets, 63.5 feet (19.35 meters) southwest of tree near edge of street, and 57.3 feet (17.47 meters) west of tree south of first; marked by wooden stake. True bearings: southeast corner of railway station, 89° 48′.8; northwest corner of chief engineer's house, 204° 23′.1.

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BELGIAN CONGO—*continued.*

Kadia, Tanganika, 1914.—On western extremity of smaller of two islands built up in dry-season marsh, on south side of navigated channel of Lualaba River, 23.3 feet (7.10 meters) northwest of small tree. True bearing: west pillar supporting roof of white man's house on larger island to northward, 219° 23.′0.

Kafakumba Lulua, 1914.—In square about which public buildings are grouped, directly in front of house occupied by commissioner of police and 42.98 meters distant, 40.93 meters northeast of flagpole, in line with south end of house directly opposite that of commissioner of police, 19.29 meters east of small tree, 25.56 meters from lone tree to northwest, and 24.78 meters south of tree nearest travelers' house; to be marked by commandant by a pillar of ant-hill clay. True bearings: south corner of commandant's house, 32° 19′.8; south end of controller's house, 111° 26′.3; southwest corner of house of commissioner of police, 301° 05′.2.

Kambove, Upper Luapula, 1914, 1920.—Station of 1920, which was close reoccupation of that of 1914, is on grounds of American Methodist Episcopal Mission about 1 kilometer south of railway station, on summit of highest wooded hill on grounds southwest of mission buildings, 12.5 meters east of base of ant-hill, 5.25 meters south of small tree, and 13.55 meters west of a second tree; marked by round hole in top face of roughly rectangular rock about 20 by 150 centimeters extending 10 centimeters above ground. True bearings: right gable of sheet-iron building in town, 179° 40′.2; left end of roof of railway shed, 184° 59′.6.

Kapanga, Lulua, 1914.—On triangular parking bounded by three avenues, lined by hedges of Spanish-bayonet, 5.3 meters north of hedge along avenue on south which runs westward to Kapanga's village, 9.5 meters west of hedge along avenue on east which passes to west of travelers' house, 29.75 meters north of flagpole which stands in avenue bounding parking on west, 30.43 meters nearly south of large tree east of avenue which passes travelers' house; marked by wooden stake, 5 centimeters in diameter, projecting 18 centimeters out of ground. True bearing: center pillar of veranda of unoccupied Kasai Company building across ravine, 154° 51′.2.

Kapiri, Upper-Luapula, 1914.—About 4 kilometers east of old Kapiri depot for transports, near Zimmeru's Kafir store, between cook-house and main road, 41.2 feet (12.56 meters) south of southwest corner of cookhouse, and 68.5 feet (20.88 meters) north of near edge of road; marked by wooden stake.

Kayoyo, Lulua, 1914.—On open sandy court in front of office of Chef de Poste, 37.80 meters west of northwest corner of that office, 12.8 meters north of center of avenue leading from office to flagpole, and 17.30 meters southwest from tree northwest of office; marked by small wooden stake. True bearings: flagpole, 70° 04′.1; northwest corner of office of Chef de Poste, 272° 59′.7.

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BELGIAN CONGO—*continued.*

Kilometer 123, Tanganika, 1914.—In bush south of railway, approximately 105 meters south of kilometer post numbered 123, about 8 meters west of ant-hill, 98.3 feet (29.96 meters) and 108.7 feet (33.13 meters) respectively from two comparatively large trees; marked by wooden stake .

Kilometer 225, Tanganika, 1914.—In bush southeast of railway a little beyond kilometer post 225; marked by long stake projecting about 12 inches (30 cm.) above ground.

Kimbundji, Upper Luapula, 1914.—Within quadrangle upon which public buildings face, near southeast side, upon slight elevation, base of partially removed ant-hill, 50 meters east of flagpole, 38.9 meters east of palm clump in line with flagpole, 37.18 meters north of west corner of postmaster's residence, and 41.37 meters west of north corner of state office. True bearings: center post of pavilion on brow of hill, 62° 10′; flagpole, 83° 24′.5; east corner of armory, 170° 07′.7; north corner of office, 287° 17′.7.

Kindu, Moniema, 1914.—On hill west of railway station, on bank west of road leading up hill, east of road leading from residence of railway doctor to residence of chief of railway, directly in front of third travelers' rest-house north of junction of roads, 64.9 feet (19.78 meters) from its southeast corner, 96.8 feet (29.50 meters) northeast of northeast corner of second rest-house, and 32.0 feet (9.75 meters) east of mango tree by roadside; marked by wooden stake. True bearings: spire on doctor's house, 14° 55′.0; east leg of wireless tower, 213° 48′.9; southwest corner of railway station, 289° 51′.

Kongolo, Tanganika, 1914.—In open field northeast of post-office, 25.4 feet (7.7 meters) southwest of diagonal path leading northwest, 201.9 feet (61.54 meters) northeast of northwest corner of new post-office, 22.9 feet (6.98 meters) north of tropical papaw tree, and about 300 meters east of meteorological station of the Minerkat Society; marked by wooden stake. True bearings: flagpole at Place Emile Wangermee, 22° 15′.0; northwest corner of new post-office, 48° 20′.0; northeast veranda-pillar of station-master's house, 95° 52′.2; northeast corner of present post-office, 346° 52′.5.

Kwamouth, Middle Congo, 1914.—Northwest of telegraph office, on bank of Kasai River, 37.7 feet (11.49 meters) north of masonry pier erected by Belgian government as an observation point, and exactly in line with pier and a steel telegraph pole on opposite side of river used by them as azimuth mark. True bearings: steel telegraph-pole on opposite side of river, 186° 27′.2; steel telegraph-pole on south side of river, 219° 48′.4.

Kyembi, Kasai, 1914.—In open place at eastern side of village, northwest of gardens, 22.81 meters nearly south of largest tree in that part of village, 12.68 meters northeast of smaller tree, 10.1 meters southwest of house; marked by small wooden stake.

Leopoldville, Middle Congo, 1914, 1916.—Two stations, designated *A* and *B*, were occupied. Station *A*, occupied in March 1914, and reoccupied in 1916, is on top of Mount Leopold just west of Leopoldville, over concrete pier known as "Signal Leo," 18 inches (45.7 cm.) square and 3 feet (0.9 meter) high, used for latitude and longitude observations and for triangulation. True bearing: cross on Catholic church in Brazzaville, 8 kilometers, 203° 51′.0. Signal Leo is 442 meters northwest of Stanley Place, at which previous observations had been made by Lemaire.

In November 1914 station *B* was established 42.78 meters northeast of station *A*, exactly in line with *A*

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BELGIAN CONGO—*continued.*

Leopoldville, Middle Congo, 1914, 1916—continued.

and Catholic church in Brazzaville, and 19.55 meters southeast of hole in large boulder; marked by large wooden stake projecting 35 centimeters above ground.

Lisala, Bangala, 1914.—About 150 meters east of state beach, 6.8 feet (2.07 meters) north of triangulation and observation pillar of Hydrographic Service, on line produced through pillar from similar one on island 1,500 meters distant, and 9.1 feet (2.77 meters) south of west hut of two between saw pits and soldiers' quarters. True bearings: lone palm on beach, 80° 49′.7; gable of soldiers' quarters, 87° 27′.3; pillar on island, 346° 19′.3.

Lowa, Lowa, 1914.—In field east of building used as armory, 90.3 feet (27.52 meters) southeast of post marking Lemaire's station of 1900, about 54 feet (16.5 meters) south of center of street running east from armory, 39.1 feet (11.92 meters) south of palm tree near this street, and 92.8 feet (28.29 meters) east of front of armory; marked by stake. True bearings: Lemaire's post, 122° 56′.2; flagpole, near river bank, 312° 02′.0.

Luebo, Kasai, 1914.—On grounds of American Presbyterian Mission, 30.2 meters west of central path leading to river, 22.9 meters east of diagonal path leading to Captain Scott's house, 24.7 meters north of tree, 48.06 meters southwest of south corner of cemetery, nearly in front of church across main path through grounds from villages; marked by wooden stake driven flush with ground. True bearings: east corner of Captain Scott's house, 15° 04′.5; headstone at Mrs. Morrison's grave in cemetery, 191° 22′.4; flagpole at state post, 344° 42′.2.

Lufupa River, Upper Luapula, 1920.—On main path from Kalene Hill to Ruwe, about 2 kilometers south of chief Musokantanda's village, on level ground inclosed in sudden-U-bend of Lufupa River, 12 paces east of path measured from point 65 paces up path east of bridge, and 30 paces from river on east.

Lukolela, Middle Congo, 1914.—In open space inclosed by magistrate's office, officers' dwelling, and native market, 24.9 feet (7.59 meters) south of pillar marking north end of meridian, 42.5 feet (12.95 meters) east of southeast corner post of magistrate's house, 64.8 feet (19.75 meters) east of southeast corner post of officers' dwelling, 101.3 feet (30.88 meters) south of flagpole, and 46.0 feet (14.02 meters) north of market fence; marked by wooden stake.

Luluabourg, Kasai, 1914.—On grounds of St. Joseph's Mission, in coffee plantation about 200 meters northeast of church, exactly in line with two crosses on spires of church, between row of pineapples and young palms and parallel hedge row of Spanish bayonets, 3.7 meters east of former and 4.8 meters west of latter, 61.40 meters west of west corner of cow stable; marked by wooden stake. True bearing: church spires, 45° 43′.9.

Lusambo, Sankuru, 1914.—In mango grove southwest of house occupied by commandant of troops at Lusambo, between two rows of mango trees running south from street upon which house faces, 9.55 meters southwest from second tree in eastern row, and 12.49 meters southeast from second tree in western row, 57.05 meters southwest of northern pillar erected by Willemoës D'Obry; marked by wooden stake. True bearings: east leg of northern wireless tower, 111° 24′.0; southeast corner pillar of commandant's house, 220° 16′.4; north D'Obry meridian pillar, 258° 07′.4; south D'Obry meridian pillar, 333° 56′.5.

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BELGIAN CONGO—*continued.*

Malela, Moniema, 1914.—About 82 paces southwest of railway track, nearly opposite south Y switch, between two travelers' rest-houses, 27 paces southeast of one nearest dwelling of station-master; marked by wooden stake. True bearing: north corner of travelers' rest-house, 299° 04′.0.

Matadi, Lower Congo, 1914, 1920.—Station of 1920 is a proximate reoccupation of that of 1914; it is on summit of rocky hill about 1 mile (1.6 kilometers) north of wharf, between River Congo and railroad line to Kinshassa, at end of small path leading north from east side of powder magazine to summit of hill, and 30 paces southeast of wooden pyramid marking trigonometrical station. True bearings: trigonometrical station, 124° 41′.2; near gable end of house across valley, 3 kilometers, 218° 50′.1; west gable end of red-roofed building, 1.5 kilometers, 329° 53′.9.

Mazanguli, Upper Luapula, 1914.—South of Mazanguli's village, in manioc garden north of caravan trail which enters village from west, 50 feet (15.2 meters) northwest of trail, 75.5 feet (23.01 meters) northwest of tree standing south of trail near large ant hill, 44.3 feet (13.50 meters) southwest of smaller tree. Approximate true bearings: ant-hill, 57° 04′; ant-hill, 245° 20′; ant-hill, 310° 13′; tree south of trail near ant-hill, 315° 00′.

Mukomwela, Kasai, 1914.—Southwest of chief's boma which is in central division of three into which village is divided, 28.73 meters southwest of wall of boma, 37.85 meters south of south corner of house belonging to Kasai Company, and 21.79 meters east of large tree; marked by wooden stake.

Musokantanda Plain, Lulua, 1920.—At edge of wooded bush adjoining large swampy expanse of sloping grass-land, two days' march east of Kalene Hill, at a point just north of hunting camp of Kalene Hill missionaries, and about one-third mile (0.5 km.) southwest of point where main path from Kalene Hill to Ruwe crosses channel of Mwangeza River, about midway across plain, 37 paces south of path. True bearings: prominent tree west of clump of timber, 1 kilometer, 182° 36′.0; point where path crosses Mwangeza River, 209° 41′.

Ponthierville, Lowa, 1914.—On river bank in front of house occupied by the commissioner of police, 81.4 feet (24.81 meters) west of flagpole, 130.7 feet (39.84 meters) southeast of south corner of an old fort tower, 107.1 feet (32.64 meters) southwest of edge of veranda in front of police commissioner's house; marked by an iron picket which is to be replaced by a masonry pier, as a south meridian pier, a similar pier being constructed on the meridian to the north, west of the police commissioner's house. True bearings: west corner of old tower, 126° 19′.2; west corner of commandant's house, 156° 58′.2; south corner of police commissioner's house, 237° 09′.5; south corner of district commissioner's house, 271° 00′.2; flagpole, 277° 11′.

Ruwe, Upper Luapula, 1914, 1920.—Station of 1920 which is a practical reoccupation of station of 1914, is on grassy plain about 1 kilometer southeast of mining camp on summit of Ruwe Mountain, near point where old cart road begins ascent of hill, about midway between water hole and edge of wooded bush, 70 paces east of north end of water hole. True bearings: rock on top of hill, 2 kilometers, 19° 30′.6; ant-hill on summit of hill, 0.5 kilometer, 94° 59′.9.

Sakania, Upper Luapula, 1914.—East of railway station, between railway and main road, 20 meters south of

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BELGIAN CONGO—*continued.*

Sakahia, Upper Luapula, 1914—continued. center of main road, and 60.80 meters west of southwest corner of hospital; marked by stake. True bearings: southeast corner of railway station and office, 87° 51′.9; west edge of tree on top of ant-hill, 199° 57′.6; southwest corner of hospital, 287° 21.′2.

Sakepalo, Lulua, 1914.—Southeast of Sakepalo village, within triangle of large trees about 40 meters north of camping place provided for travelers, 12.35 meters, 17.80 meters, and 13.38 meters respectively from trees to west, northeast, and southeast, and 7.5 meters north of path leading to cassava garden east of village; marked by wooden stake.

Stanleyville, Stanleyville, 1914.—South of post-office in triangular plot formed by street along river wall and a walled open drain, 84.4 feet (25.73 meters) west of temporary bank building, 91.5 feet (27.89 meters) north of river wall, 77.8 feet (23.71 meters) northeast of nearest corner of drain culvert, and 26.7 feet (8.14 meters) southeast of nearest point on drain wall; marked by wooden stake driven flush with ground. True bearings: peak of railway manager's house on south side of Congo River, 21° 13′.8; north meridian pillar, 205° 08′.9; gable south end of bank building, 269° 16′.9; triangulation and astronomical pillar of Hydrographic Service, 140.7 feet (42.88 meters), 329° 39′.4.

Thysville, Lower Congo, 1914.—On open field southeast of A. B. C. Hotel and southwest of Catholic church, about 50 meters southeast of street which runs in front of church, about 40 meters southeast of large tree near store, and 25.6 feet (7.80 meters) northeast of small tree in line with telephone pole about 100 feet (30.5 meters) distant; marked by a 2-inch wooden stake. True bearings: center ornament on A. B. C. Hotel, 127° 13′.0; cross on Catholic church, 218° 49′.0; northwest corner of brick house on hill, 308° 46′.2.

Tshela, Lower Congo, 1914.—On bare plot of ground north of plot of grass and shrubbery in front of house of chief of post, 43.90 meters north of flagpole in grass plot, 33.95 meters west of most northerly tree of row of shade trees east of plot, and 25.26 meters east of most northerly tree of similar row on west, 50.25 meters northwest of northwest corner of house of assistant to chief of post, east of grass plot; marked by stake. True bearing: flagpole, 18° 56′.4.

Tshibangu, Kasai, 1914.—West of village, in center of path leading northwest, 19.25 meters west of western wall of village, near junction of two branch paths coming from north and south gates respectively.

Tshinsenda, Upper Luapula, 1914.—South of broad road running eastward from railway station, approximately 206 meters nearly due east of water-tank, and 192 meters northeast of railway station, 38.2 feet (11.6 meters) south of center of road; marked by wooden stake. True bearings: north corner of water-tank, 94° 08′.8; top of abandoned wireless tower, 270° 11′.4.

Tshitaia, Lulua, 1914.—At eastern edge of village of Chief Tshitaia, nearly due east and distant about 60 meters from large tree in center of village, between two paths used for bringing water, 10.1 meters from round grass hut, 19.5 meters east of southeast corner of mud house, 13.2 meters southwest of base of irregular ant-hill; marked by wooden post 18 centimeters in diameter projecting 1.5 meters above ground with stones piled about base. True bearing: fork of large tree in center of village, 89° 30′.

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BELGIAN CONGO—*concluded.*

Tshiwana, Kasai, 1914.—West of center of village of Chief Tshiwana, 30.8 meters nearly west of large tree near center of village, and 3.52 meters west of smaller white-barked tree directly in line with first; marked by small wooden stake.

Ulamba, Lulua, 1914.—Near center of native village of Chief Ulamba, 7.8 meters southeast of path entering village from Kimpuki-Kafuchi trail, 12.4 meters southwest of round hut, 14.0 meters north-northwest of tree, and 7.0 meters northwest of center of large stone which had evidently been placed there for use in sharpening implements; marked by post 20 centimeters in diameter and projecting about 60 centimeters above surface of ground.

Waika, Lowa, 1914.—On the mission grounds of Baptist Missionary Society, about 25 paces north of central path from beach, 44 paces west of diagonal path leading to new mission dwelling, and about 8 meters northwest of northwest corner of site of proposed new chapel.

BRITISH SOUTH AND CENTRAL AFRICA.

Bethlehem, Orange Free State, 1916.—On southwest slope of hill between Bethlehem and place set apart for natives, called "Location," near cemetery, 148 paces north of northeast corner of large stone church and in line with its east face, 30 paces northeast of small abandoned quarry, 60.0 meters east of wooden corner post of small section of cemetery, and 68.8 meters southeast of stone corner post of larger part; marked by regular natural stone, 10 inches (25 cm.) long, with upper and lower faces of 5 sides of about 2.5, 2.5, 2, 1.5, and 2 inches (6, 6, 5, 4, and 5 cm.), left 1 inch (3 cm.) above surface of ground. True bearings: concrete building on hill, said to be a diamond vault, 23° 01′.6; weather-vane on clock-tower of town building in center of park, 46° 02′.4; trigonometric station, 59° 39′.4; stone post nearest edge of distant hill, 93° 42′.8; northeast corner of church, 355° 20′.7.

Bloemfontein, Orange Free State, 1916.—In King park, about 1 mile (1.6 km.) west of city post-office, 196 paces south of fountain and 41.2 meters east of nearest point on a 4-inch (10 cm.) steel water-main on west edge of road leading up to fountain; marked by tent-peg left flush with ground. True bearings: central tower on building of Grey College, 110° 38′.0; center of fountain, 181° 25′.9; flagstaff on dome of theater, 262° 46′.1; west steeple of Dutch Reformed church, 265° 10′.5; lightning rod on clock-tower of Government building, 267° 32′.9.

Broken Hill, Northern Rhodesia, 1920.—Close reoccupation of C. I. W. station of 1909, on railway line 1¼ miles (2 km.) south of railway station and township, about half mile (1 km.) south of Broken Hill Mine, 163 paces from railway, measured southeastward at right angles from a point 55 paces toward Livingstone from position marked 2013¾ miles from Cape Town, 117 paces south of northwest corner and 18.0 meters from west side of Broken Hill aerodrome-field, 123 paces west of southwest football goal-post in field. True bearings: top of most southerly of 3 stacks of smelter, 0.6 kilometer, 159° 09′.1; near gable of mine manager's office, 1 kilometer, 182° 45′.7; beacon on summit of ", inc Kopje," 211° 28′.9; southwest goal-post of football-field, 287° 55′.6; near gable of sheet-iron shed on east side of aerodrome-field, 1 kilometer, 299° 49′.7.

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BRITISH SOUTH AND CENTRAL AFRICA—*continued.*

Cape Town, Cape Colony, 1916, 1920.—Close reoccupations of C. I. W. stations of 1911, in field belonging to Valkenberg Mental Hospital back of North Lodge and bounded on north and west by grounds of Royal Astronomical Observatory. Station *A* is 83.2 meters east of fence along east side of avenue leading to hospital, and 83.2 meters north of fence along south side of field. True bearings: middle spire of three on church, 26° 58′.9; tall spire with weathercock, 99° 37′.1; east gable of hospital lodge, 124° 31′.7; top of lower part of observatory flagpole, 157° 43′.7; base of flagpole on windmill, 212° 58′.2; bottom of weather-vane on hospital tower, 317° 44′.9.

Station *C* is 29.78 meters northwest of station *A* in line through station *A* to bottom of weather-vane on hospital tower; it is 71 meters from the southeast corner of hospital lodge lot which bears 139°, and 93.7 meters from southwest corner which bears 115°, and 70.0 meters nearly east of iron fence-post which is 60.9 meters south of southwest corner of lodge lot. True bearings: center spire of three on church, 25° 38′.7; east gable of hospital lodge, 125° 17′.0; bottom of weather-vane on hospital tower, 317° 44′.9.

Durban, Natal, 1916.—About 150 paces west by south of Beattie's station of 1903, the exact place not being available on account of dwellings and other improvements, on side of harbor of Port Natal opposite city of Durban called the "Bluff," a naval reservation under control of the Admiralty and occupied by large coaling station, on grass-land on top of bluff 10 paces east of edge overlooking city and harbor and near edge of luxuriantly growing thicket, 256 paces southwest of lighthouse, 43.6 meters northwest of iron pipe about 3 inches (8 cm.) in diameter projecting above ground and inclined at angle of 70° to surface, and about 40 meters southwest of wooden time-ball staff; marked by bluish-black irregular stone 14 inches (36 cm.) long, projecting 3 inches (8 cm.) above surface of ground. True bearings: pinnacle on east gable of brick house, 0° 17′.4; flagpole near shore across bay, 50° 08′.6; flagpole part-way up hill across bay, 50° 13′.4; post-office clock-tower, 121° 22′.9; cupola of building on ridge, formerly Governor's house, 143° 33′.0; center of time-ball staff, 219° 25′.5; weather-vane on lighthouse, 234° 48′.2.

Feira, Northern Rhodesia, 1920.—On hilltop west of British Post of Feira, 240 paces west along path from magistrate's residence, 60 paces east of government messengers' compound, and 49 feet 9 inches (15.16 meters) from lone tree in true bearing 276° 23′ at junction of paths on hill summit; marked by brass cartridge-case hammered flush with ground and covered by large cairn of rocks about 2 meters diameter and 1 meter high. True bearings: top of conical peak, 16 kilometers, 44° 34′.1; trigonometric beacon on Mansanwa Mountain, 6 kilometers, 238° 03′.7.

Ginginhlovu, Natal, 1916.—Practical reoccupation of station of 1908, south of railroad station and other buildings of Ginginhlovu, near native path about 200 yards (183 meters) south of and parallel to main street of village, 187 paces south of center of road, 72 paces south of wire fence extending along back property line of town lots, and 10 paces west of bank of small brook; marked by tent-peg. True bearings: pinnacle on southeast gable of house on hill where old fort stood, 171° 55′.9; east gable of railroad station, 176° 27′.0; pinnacle on east gable of schoolhouse, 234° 46′.2.

Kafue, Northern Rhodesia, 1920.—On government reserve about 200 meters southeast of railway station, about midway between Shapcot's Hotel and railway

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BRITISH SOUTH AND CENTRAL AFRICA—*continued.*

Kafue, Northern Rhodesia, 1920—continued. station, 50 paces west of northwest corner and in line with north fence of tennis courts, 20 paces south of main road to railway station from hotel, and 48 paces east of large tree west of fire-break; marked by a 0.303 cartridge-case, covered with large mound of rocks with base about 5 feet (1.5 meters), and 3 feet (0.9 meters) above level of ground. True bearings: near gable of railway restaurant, 45° 21′.1; front gable of station-master's house, one-fourth mile (0.4 km.), 81° 42′.3; northeast corner of small building behind railway station, 125° 44′.8; northwest corner of tennis courts, 277° 43′.9; left edge of courthouse, 288° 56′.5.

Kalene Hill, Northern Rhodesia, 1920.—At site of Portuguese Boundary Survey observations, on premises of English Mission station, at northeast end of summit of Kalene Hill, on small level piece of ground among boulders, 25.25 meters south of southwest post of mission residence known as "Red Room," and 22.40 meters northwest of west post of south mission residence; marked by rectangular-shaped block of quartzite, 60 by 15 by 12 centimeters, with top face projecting about 30 centimeters above surface of ground. True bearings: southwest veranda post of Red Room, 195° 12′.4; southwest veranda post of south residence, 311° 16′.2.

Livingstone, Northern Rhodesia, 1920.—On open park land, about midway between west corner of golf-links and east fence of railway reserve, at a point 314 feet 7 inches (95.88 meters) southwest of south corner of and in line with southeast fence around bungalows, 311 feet 6 inches (94.94 meters) east of iron plate at south side of stile in east fence of railway reserve, and 36 feet 4 inches (11.08 meters) north of most westerly of 3 trees in line; marked by a 0.303 cartridge-case, covered by a cairn of rocks with base about 3 feet (90 centimeters) and 1 foot (30 centimeters) high. True bearings: grey chimney stack of buildings in railway reserve, 0.8 kilometer, 34° 38′.9; nearest goal-post of football-field, 50° 51′.1; bottom of south side of stile in east fence of railway reserve, 105° 53′.7; near gable of bungalow, 209° 47′.1; west corner of fence around golf-links, 289° 57′.7; nearest of 3 trees in line, 309° 48′.7.

Mbosa, Northern Rhodesia, 1920.—At rest-camp for travelers, on left bank of Kafue River, about half mile (0.8 km.) southeast of village, midway between open hut for white men and north edge of camp clearing, 5 paces from hut for white men, and 21 paces from large tree at south end of camp. True bearings: fork of large tree at south end of camp, 1° 25′.4; gap in mountain range at right of Mount Mukwashi, 8 miles (12.9 km.), 100° 58′.5; top of north precipitous edge of Mount Chibaru, 2 miles (3.2 km.), 177° 30′.5.

Mburuma, Northern Rhodesia, 1920.—At north entrance to rest-camp for travelers, in middle of roadway leading from rest-camp to village, 69 paces south of nearest hut in village, and 24 paces northwest of large tree in rest-camp. True bearings: outer right edge of nearest hut in village, 173° 39′; large tree in camp, 318° 56′; top of hut for white men, about 20 paces, 349° 09′.

Shapanga, Northern Rhodesia, 1920.—At rest-camp for travelers, on bank of Zambezi River, about half mile (0.8 km.) south of village of Shapanga, 19 paces west of hut for white men, and 5 paces west of hut for cook, in middle of clearing. True bearings: trunk of large tree in camp, 18 paces, 315° 39′; dip in mountain range across river, 353° 55′.4.

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BRITISH SOUTH AND CENTRAL AFRICA—*concluded.*

Upington, Cape Colony, 1916.—In north part of town, about 200 yards (183 meters) north of Orange River, on rocky ridge perpendicular to river, about 45 feet (14 meters) southwest of south corner of stone-walled corral. True bearings: east gable of farmhouse, 66° 48′.7; north pinnacle on church, 86° 56′.1; church steeple, 220° 08′.9; center of rocky hill just in front of V formed by hills in distance, 289° 38′.2; beacon on distant hill, 296° 57′.2.

Valkenberg, Cape Colony, —See Cape Town.

Victoria Falls, Southern Rhodesia, 1920.—Close reoccupation of C. I. W. "new station" of 1909, in Victoria Falls Park, about midway between hotel and Devil's Cataract, about 150 yards (137 meters) south of intersection of path from hotel to cataract with railway, 60 paces east of path from hotel to cataract, measured from a point in path 143 paces southwestward from intersection of path with rails, and 50 paces south of branch path to bridge. True bearings: center of plate marked "20," about 200 yards (183 meters), 172° 02′.3; bottom of railway sign-board, 193° 58′.6.

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Abong-Mbang, 1919.—About 3 kilometers west of government post along main road to Mangwati, near south corner of property of Blat and Perinaud on south side of Nyong River and just west of a small river, Aboung-Doung, 29.80 meters north of sign-board near main road west of bridge, 19.10 meters east and 11.05 meters north respectively from two palm-oil trees; marked by heavy tarred post bearing small board with inscription C. I. W. 1919. True bearings: sign-board near main road, 35° 18′.3; top of mast with pigeon loft, 184° 38′.6; east gable end of factory residence, 190° 50′.5; palm-oil tree near river, 346° 15′.

Afade, 1919.—In southeast corner of market place, just outside and 12.8 meters southwest of south side of entrance to government rest-camp, 55.5 meters south of southwest corner of mud-walled compound north of rest-camp, and 4 paces and 6 paces from paths to east and south respectively near margin of market place. True bearings: fork in large shade tree, 46.9 meters, 108° 37′; left side of door of sultan's compound, 158° 48′.9; southwest corner of mud wall of compound north of rest-camp, 166° 54′.8; bottom of south side of entrance to encampment, 215° 41′.6.

Akonolinga, 1919.—North of base of steps leading up hill from Nyong River to residence of commandant, at French government post, west of small path, near southeast corner of post garden, over large cement-covered pillar, 0.80 meter square, projecting 0.15 meter high; marked by cement pyramid 0.35 meter square built on top of pillar, with four faces bearing inscription "C. I. W. 1919". True bearings: fork of large tree on sky-line, 5 kilometers, 44° 06′.7; top of tower in northwest corner of fort, 80 meters, 206° 51′.4.

Atok, 1919.—At trading post of Blat and Perinaud, on low ridge on left bank of Nyong River, in middle of pathway leading from residence to river, 22.00 meters from northwest corner post and 20.70 meters from northeast corner post of residence, and 16.25 meters southeast of southeast corner post of small store. True bearings: northwest corner post of residence, 34° 49′.5; southeast corner post of small store, 157° 19′.4; northeast corner post of residence, 351° 34′.4.

Bama, Bornu, 1919.—At government encampment on right bank of Jadseram River, southwest of village,

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CAMEROUN—*continued*

Bama, Bornu, 1919—continued.
south of long thatch building used as stable, north of low hedge bounding encampment on south, 14 meters east of center of main path leading north along river, 28.9 meters east of nearest large tree on river bank, and 20.2 meters southeast of southwest corner of stable. True bearings: southwest corner of stable, 150° 41′.1; top of nearest hut, 173° 11′.4.

Boudjiri, 1919.—On main road to Tibati, 65 kilometers north of Yoko, in grounds of government rest-house of Boudjiri, 5.2 meters south of road running through compound, 17.0 meters east of east wall of rest-hut for Europeans, and 37.05 meters southeast of sign-post west of main road; over a large granite rock lying with its axis northwest and southeast; marked by cross cut in northeast quadrant of rock to indicate exact instrument center. True bearings: top of center pole of rest-hut, 97° 26′; bottom of sign-post west of main road, 112° 28′.3; top of largest hut of village, 0.5 kilometer, 163° 33′.0.

Campo (Eclipse), 1919.—In bare sand, at northeast end of avenue of young palm trees in front of European guest-houses, 115.20 meters northeast of northeast corner of Lieutenant's house, just southeast of junction of road to Kribi and road to N'Jabessan, and just south of Haussa village within this junction; marked by a pyramidal boundary stone 15 centimeters square, top of which projects 20 centimeters above surface of sand. True bearings: bottom of large white cotton-wood tree on coast in Spanish Guinea, 2.5 kilometers, 38° 40′.3; pole carrying lightning conductor outside Lieutenant's residence, about 120 meters, 50° 23′.6; top of white wooden pyramid on beach used as harbor mark, about 120 meters, 61° 31′.6; bottom of left edge of iron sheet painted with black and white stripes as harbor mark, about 250 meters, 311° 37′.5; right gable end of market, about 250 meters, 343° 02′.9.

Dikoa, Bornu, 1919.—Near middle of large open space between sultan's palace and market place, west of former German post now used as a rest-house for Europeans, 21 paces east of intersection of two diagonal paths crossing open space, 70.5 meters west of and in line with north side of gate-house of rest-camp, 98.1 meters northwest of south corner of wall around rest-camp, and 59.7 meters north of northwest corner of small mud-walled compound. True bearings: northwest corner of wall around rest-camp, 187° 21′.6; near gable end of iron-roofed building, 100 meters, 204° 07′.7; iron pole over entrance to rest-camp, 246° 50′.7; southwest corner of mud wall around rest-camp, 290° 40′.1.

Douala, 1915, 1919, 1920.—Station of 1919 is exact reoccupation of C. I. W. station of 1915, on open ground southeast of junction of Kitchener Street and Dwarf Road, about halfway between band-stand and Restaurant Favrat, 72.55 meters southwest of southwest corner of restaurant building, 53.28 meters southeast of hydrant at street junction, and 11.6 meters northeast of center of graveled path leading from junction southeastward. True bearings: hydrant at street junction, 114° 06′.6; flagpole on river bank, 0.3 kilometer, 116° 23′.1; rightmost veranda post of bank building, 50 meters, 166° 54′.9; center veranda post of white bungalow, 0.3 kilometer, 233° 26′.4; top of Restaurant Favrat, 253° 29′.9.

Station *B*, occupied as being more likely to be available in the future, is in Government House grounds, 17.8 meters south of southeast corner of paved tennis court and exactly in line with its east

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CAMEROUN—*continued.*

Douala, 1915, 1919, 1920—continued.
side, 23.97 meters southeast of southwest corner of court, 55.3 meters southwest of telephone-pole near administration building, and 66.3 meters northeast of bottom of lamp standard near gate of grounds. After occupation of May 1919, a cement-covered brick monument, 50 centimeters square at base and 70 centimeters high, was erected, whose top face, 30 centimeters square, is marked "C. I. W. 1919;" a drill hole indicates exact point occupied in January 1920, and very nearly point occupied in May 1919. True bearings: left edge of doorway of low white building, 0.5 kilometer, 09° 36′.4; bottom of lamp standard outside small gate, 56° 16′.6; lamp standard at cross paths in grounds, 105° 25′.2; bottom of telephone-pole outside administration building, 249° 54′.3.

Douhou, 1919.—On open space outside north entrance to government encampment, about 300 meters south of sultan's compound, on east side of road, near grass border, 31.25 meters north of northeast corner, and 35.20 meters northeast of northwest corner of mud wall around encampment. True bearings: left edge of cube-shaped rock on gap in hills, 0.5 kilometer, 36° 31′.1; northwest corner of mud wall around encampment, 58° 43′.5; northeast corner of mud wall around encampment, 353° 41′.9.

Doumo, 1919.—About 45 paces east of main road from Lomié to Abong-Mbang, at north edge of path from road to rest-house, 47.35 meters west of northwest corner of rest-house which bears 275° 37′.0 west of true south.

Dragh, 1917.—On west bank of Chari River, between native village and steep river bank, just south of landing place, and 4 meters from edge of bank. True bearing: prominent branch of dead tree across river, 340° 56′.6.

Ebolowa, 1919.—On campus of American Presbyterian Mission, on low hill called Elat by natives, about 1 mile (1.6 km.) southeast of Government post of Ebolowa, on lawn between wooden residences of Mr. Hope and Reverend Evans, over higher or west end of a pear-shaped protruding rock of gneiss, about 3 feet (0.9 meter) long and 2.5 feet (0.8 meter) wide at east end; marked by cross cut in rock to mark exact instrument center. True bearings: bottom of mango tree, 38.8 meters, 22° 09′.8; left side door of church, 250 meters, 30° 35′.8; south corner of office building, 120 meters, 186° 30′.8; bottom of southmost of two posts at entrance of Hope residence, 84.35 meters, 239° 01′.2; bottom of northwest corner of Reverend Evans's residence, 46.15 meters, 336° 59′.8.

Edea, 1919.—On earth road leading along left bank of Sanaga River from Camp de Tirailleurs to Catholic Mission station, at first bend in road after descending hill from barracks, about 200 meters west of prison on hill, 43 paces northwest of junction with road, of small path leading to river, and 2 paces from north edge of road at bend. True bearings: bottom of leftmost of two trees growing together, one-third kilometer, 3° 54′; near gable end of northmost visible bungalow on hill, one-fourth kilometer, 252° 05′.0; bottom of left edge of prison, 272° 06′.6; left gable end of large iron shed on hill, one-fourth kilometer, 298° 59′.7; inner curve of bend in road, 160 paces, 329° 07′.

Efulen, 1919.—On premises of American Presbyterian Mission, on spur of hill below and south of residences on summit, at bottom of path leading down steep hillside from hospital, and halfway between two wooden isolation wards situated on flat land of spur, 17.7

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CAMEROUN—*continued.*

Efulen, 1919—continued.
meters from northeast corner and 17.2 meters from southeast corner of west ward, and 18.1 meters from northwest corner and 16.9 meters from southwest corner of east ward. True bearings: southeast corner of west ward, 21° 32′.6; northeast corner of west ward, 148° 09′.9; bottom left edge of southwest post of dispensary on hill, 159° 37′.9; bottom right edge of hospital building, 189° 37′.9; northwest corner of east ward, 201° 19′.8.

Eseka, 1920.—On hillside northwest of post-office and railway station, in northwest corner of garden of government post, 45 paces from northwest corner and 50 paces from northeast corner respectively of shed for native troops, and 27 paces northwest of a palm tree in line between station and northeast corner of shed. True bearings: near gable end of railway rest-house, 100 meters, 293° 00′.2; right side of large tree near road, 200 meters, 328° 32′.5; north gable end of residence, 250 meters, 337° 17′.7; northwest corner post of shed for troops, 350° 14′.9.

Garoua, 1914, 1919.—Station of 1919 is about 20 meters southwest of station of 1914, which was found to be unsuitable on account of nearness of new custom-house. At base of small knoll, 47.05 meters southwest of south corner of French custom-house, 102.2 meters southwest of old German custom-house, and 154.2 meters southeast of south corner of Niger Company compound. True bearings: south corner stone of Niger Company compound, 134° 12′.7; west gable end of southmost store of Niger Company, 149° 14′.7; near gable end of Niger Company residence, 155° 25′.9; ornament on near end of French custom-house, 203° 10′.3.

Station *B*, established because the station of 1914 was subject to flood and not on government property, is near middle of military training ground at government post, about 1.5 kilometers along main road northwest of Niger Company wharf, between market and barracks, 64 paces west of ditch beside main road, 23.75 meters from east end of and in line with north barricade of two set across training course, 29.90 meters from east end of south barricade; marked by brick pillar faced with cement, 25 centimeters square, standing 130 centimeters above surface of ground and having triangular grooves in top for instrument foot-screws. True bearings: east end of north barricade, 61° 12′; southmost post of school, 68° 58′.5; top of southwest edge of commandant's house, 0.5 kilometer, 81° 55′.9; gable end of offices of circonscription, 100° 05′.8; right gable end of eastmost residence at post, 139° 49′.1; right end roof of post-office, 154° 11′.9.

Heldu, 1919.—At government encampment on north bank of a creek about 100 meters north of north bank of Marol River, in path leading east from encampment, 6 paces west of junction of path with main road to Rei Bouba, and 180 paces from north bank of Marol River. True bearing: top of kitchen hut in encampment, 80° 19′.5.

Kaega-Matekel, 1919.—In main road to Ngaoundere, at first bend north of government encampment on hill, 174 paces along road from north entrance to encampment, 2 paces from west side and 4 paces from east side of road. True bearings: top of eastmost visible hut of encampment, 345° 06′.3; north gable end of European rest-hut, 350° 32′.8.

Kompina, 1919.—In thick forest bush, 135 paces along small path leading southeast at right angles to railway from a point 230 paces southwest of Kompina railway

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CAMEROUN—*continued.*

Kompina, 1919—continued.
station, within a fork formed by junction of two bush paths and midway between them, 8 paces southeast of junction of paths and 4 paces northwest of large tree. True bearing: bottom of prominent white tree, north of railway, 141° 59′.0.

Kribi, 1919.—On military parade-ground in front of barracks for native troops, about 120 meters northwest of captain's residence, 14.75 meters north of west corner and 18.05 meters west-northwest of north corner of concrete foundation of house at cross-roads, 80.77 meters southwest of pillar on right of entrance to barracks, and 94.32 meters south-southwest of east corner pillar of house to north; marked by cement pyramid 0.6 meter high, with base 0.35 meter square, top of which is left 0.15 meter above surface of ground. True bearings: top of Roman Catholic church steeple, 1 kilometer, 57° 52′.6; ornament on turret of club-house, two-thirds kilometer, 111° 46′.4; near gable end of house, 146° 19′.9; southeast corner of east pillar of house, 193° 15′.5; northwest corner of barracks, about 95 meters, 215° 20′.3; ornament over entrance to barracks, 231° 05′.1; north corner of concrete foundation, 286° 05′.5; east edge of captain's residence, 324° 36′.8; west corner of concrete foundation, 346° 05′.6.

Lagdo, 1919.—About 200 meters west of king's compound, in line with two large baobab trees in southeast corner of grass-land, 20.40 meters west of nearest baobab tree, 26.85 meters northeast of tree on south fringe of grass-land, and 17 paces south of nearest of three large granite boulders to north. True bearings: top of cleft in rocky pinnacle, 0.5 kilometer, 23° 03′.8; top of armchair rock on crest of hill, 1 kilometer, 152° 06′.8; bottom of large baobab tree to east, 272° 53′.2; top of large red rock on hillside, 2 kilometers, 287° 16′.2.

Lomié, 1919.—At French government post, in southeast corner of Place Publique adjoining Fort Niger on east, 52.05 meters south of shady tree, 50.05 meters southeast of flagstaff, and 41.85 meters northeast of northwest corner of school; marked by small brick pillar, about 30 centimeters square, standing about 50 centimeters above surface of ground. True bearings: northwest corner of school, 22° 19′.1; bottom of southwest corner of Fort Niger, 98° 45′.4; top of southeast corner of tower of fort, 116° 59′.8; bottom of flagstaff, 135° 04′.0; northeast corner of wall of fort, 141° 25′.2.

Lum, 1919.—At first bend in earth road to Nkongsamba, 382 paces east along road from railway which crosses road at a point about 250 yards (229 meters) north of Lum station, at north edge of road, 21 paces east of southmost of 3 palm-oil trees in adjacent plantation, and 200 paces east of a large cottonwood tree on north side of road. True bearing: left edge of large white tree to west of railway line, one-fourth mile (0.4 km.), 75° 21′.5.

Mancha, 1919.—About 91 paces along main road to Ngaoundere, northeast of government encampment of Mancha, about one pace west of middle of road, 8 paces southwest of junction of small native track from carriers' camp with main road, and 9 paces north of tree. True bearing: northwest gable end of European rest-hut, 41° 09′.3.

Mangal, 1919.—Near middle of open space between government rest-house and matting inclosure around king's residence, 41.00 meters west of southeast veranda post of government rest-house, and 35.00 meters east of south side of door of guest-hut at entrance to

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CAMEROUN—*continued.*

Mangal, 1919—continued.
king's compound. True bearings: top of guest-hut at entrance to king's compound, 79° 38′.0; southeast pillar of government rest-house, 269° 33′.9.

Moubi, 1919.—At south end of government encampment, north of village of Loguar, south of and in line with east side of more southerly of two European houses, 72.15 meters from westmost post and 65.80 meters from eastmost post respectively of south European house, 31.15 meters from base of lone tree near path to south, 35 paces south of large ant-hill and 13 paces east of path leading to village. True bearings: top of vertical mass of rock on distant mountain, 40 kilometers, 69° 21′.1; west post of European house, 145° 53′.7; east post of European house, 166° 55′.5; bottom of cleft in large cube-shaped rock on hill to southeast, 10 kilometers, 268° 45′.5.

Ndium Ndunajum, 1919.—Northeast of government encampment, in middle of main road to Rei Bouba, 41 paces north of northmost path from encampment, and 7 paces north of small track leading northeast to carriers' camp. True bearings: east end roof of eastmost rest-hut, 20° 27′.9; top of conical hut in northwest corner of compound, 43° 56′.7.

Ngala, Bornu, 1919.—In small open space outside west entrance to government rest-camp. True bearings: large tree near northwest corner of encampment, 26.7 meters, 215° 03′.4; northwest corner of wall around encampment, 21.4 meters, 229° 36′.1.

Ngaoundere, 1919.—At government post, in front of captain's residence and sergeant-major's quarters, near north apex of triangular tract bounded by main road to native village and two paths to sergeant-major's quarters, 9.9 meters from northeast boundary and 8.5 meters from northwest boundary of tract, and 70.55 meters northeast of center pole of captain's residence; marked by triangular pyramid of granite, about 55 centimeters wide at base and 65 centimeters high, left projecting about 20 centimeters above the surface. True bearings: right edge at bottom of center pole of captain's residence, 49° 58′.2; top of cube-shaped mass of rock on hill, 1 kilometer, 90° 11′.6; bottom of eastmost post of doctor's house, 143° 54′.3; bottom of northmost post of post-office, 200 meters, 269° 18′.4; bottom of westmost post of sergeant-major's quarters, 332° 46′.3.

Nghila, 1919.—In village of King of Nghila, about 1 kilometer north of government rest-house on main road, in middle of village in large open space around which huts are grouped, 52 paces south-southwest of palaver house, and 27 paces northeast of goat-shed.

Nkongsamba, 1919.—In native troops cantonment, on a hill just north of railway station, at northwest end of a wide path leading up hill from point on railway line about 140 paces northeast of station, in center of pathway, exactly in line with northwest side of small open mat shed east of path, and 19.1 meters southwest of its west corner, 28.9 meters northwest of northwest corner of mat shed southwest of path, and 47 paces beyond westmost of two trees along east side of path. True bearings: left gable end of south railway shed, 7° 21′.5; bottom of north corner of mat shed at end of path, 131° 35′.6; west corner of mat shed east of path, 222° 45′.6; left gable of John Holt's bungalow, one-third mile (0.5 km.), 342° 33′.7; left gable of railway station, 1,000 feet (0.3 km.), 351° 15′.9.

Olama, 1919, 1920.—On premises of American Presbyterian Mission station, at point on south edge of path running west-southwest from mission house, about midway

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CAMEROUN—*continued.*

Olama, 1919, 1920—continued.
between guest-house and house of native evangelist, 196.64 meters from southwest post of mission house, 86 paces from point on path opposite evangelist's house, 140 paces from point on path opposite schoolhouse, and 81 paces from point on path opposite guest-house; marked by an ironwood post 10 by 20 by 100 centimeters, left 30 centimeters above level of ground, a deep cross cut in top face indicating exact instrument center. True bearings: right gable of evangelist's house, 254° 14′.7; near end ridge-pole of mission house, 258° 43′.3; left gable end of school shed, 267° 02′.1.

Rei Bouba, 1919.—On open ground outside of city, about 200 paces west of south gate, 59 paces east of southeast corner and in line with south side of isolated compound of mud huts surrounded by a wall of straw matting, and 32 paces south of edge of moat along south wall of city. True bearings: top of hut in southeast corner of compound, 97° 32′.4; top of south gate of city, 254° 55′.4; highest peak of distant range, 30 kilometers, 309° 11′.2.

Sanaga, 1919.—In northeast corner of government rest-house compound, on north bank of Sanaga River, on main road from Yaounde to Yoko, east of rest-house, 31.25 meters northeast of south corner of rest-house, and 37.90 meters east of its north veranda post. True bearings: bottom of right edge doorway of rest-house, south of river, 1 kilometer, 18° 57′.2; bottom of south corner of rest-house, 74° 21′.9; bottom of north post of veranda of rest-house, 103° 07′.9.

Ssorao, 1919.—At government encampment north of village, in center of path leading from hut reserved for Europeans along low spur running south from encampment, 56 paces along path from south door of European hut, the southmost hut of encampment. True bearings: top of westmost visible hut of encampment, 145° 59′.2; top of European hut, 171° 56′.2.

Teisan, 1919.—At north end of native village, 26.9 meters north of northwest corner of rest-house, and 32.8 meters north of northeast corner of west line of huts of village. True bearings: northeast corner of west line of huts, 0° 40′.9; northwest corner of European rest-house, 332° 51′.4.

Tibati, 1919.—Near southeast corner of government rest-house compound, which is on main road to Banio, about 1 kilometer south of government post and west of cross-roads to Yoko and Ngaoundere, at a point just north of road to Banio, 23.75 meters south of southwest post of porch of European rest-hut, 43.25 meters south of eastmost of two trees in middle of compound, and 50.51 meters west of sign-post at southeast corner of cross-roads. True bearings: bottom of southwest post of porch of European rest-hut, 162° 27′.8; eastmost of two trees in compound, 189° 14′.4; sign-post at junction of roads, 288° 57′.4.

Yaounde, 1919.—About 1 mile west of Yaounde, 5 paces north of north edge of road, in garden in front of a tiled mud building on hill, formerly a German government school, exactly in line with east side of schoolhouse, 28.00 meters south of its southeast corner and 33.90 meters southeast of its southwest corner, 50.60 meters southwest of southwest corner of mud building used as kitchen; marked by two red bricks sunk flush with ground, to be replaced by a small brick pier about 50 centimeters high. True bearings: bottom of southwest corner of schoolhouse, 151° 47′.9; bottom of southeast corner of schoolhouse, 186° 27′.6; bottom of southwest corner of kitchen, 222° 48′.6; south gable of teacher's residence, 254° 38′.7.

AFRICA.

CAMEROUN—*concluded.*

Yoko, 1919.—On slope about 200 meters east of east gate of fort, near center of triangular piece of land inclosed on northeast by a field, and on west and south by roads to Tibati and Deng-Deng, 14 meters east of former and 13 meters north of latter, 25.28 meters north of sign-post at junction of roads with road to Yaounde, and 39.35 meters north-northwest of eastmost support of seats under tree; marked by a slab of granite 10 by 20 by 60 centimeters, top face being left 0.1 meter above surface of ground, a small sink-hole indicating instrument center. True bearings: sign-post at junction of roads, 12° 04′.9; flagstaff on fort, 103° 10′.2; northeast corner of fort, 114° 26′.1; bottom of eastmost support of seats under tree, 334° 59′.3; pole of large hut of village on hill to south, 0.5 kilometer, 357° 33′.6.

CYRENAICA.

Bengasi, 1914.—On ground belonging to Fwayhat mission, about 5 kilometers southeast of Bengasi, in a field about 200 meters northeast of mission building, 12.1 meters north of outer end of stone wall running northeast from front of mission building, 7½ meters northwest at right angles from a point in extension of line along northwest face of wall; marked by a tent-peg driven flush with ground. True bearings: minaret, 135° 22′.7; tallest minaret in Bengasi, 135° 46′.7; center line of concrete sentry tower, 345° 00′.9.

Derna, 1914.—On sloping ground southeast of town, near new military barracks, 36.2 meters southwest of near edge of road leading to barracks, 36.5 meters northwest of stone wall inclosing ground belonging to barracks, and 40.0 meters southeast from middle of southeast side of stone hut; marked by hole in top of cement post 16 by 16 centimeters at top, projecting 4 inches above ground, anchored in underlying rock 25 centimeters below surface, and covered by pile of loose rock. True bearings: top of lighthouse, 154° 39′.4; flagstaff on wireless station, 156° 54′.9; north corner of barracks building, 271° 33′.6.

Marsa Susa, 1914.—On prominent hill immediately west of town, 21.4 meters southeast and 17.4 meters northeast respectively from northeast and southeast corners of an excavation surrounded by primitive rock-hewn dwellings; marked by tent-peg driven flush with ground. True bearings: cross on wooden chapel, 257° 19′.3; south side of Turkish stone windmill, 261° 04′.3; southwest corner of stone house, 301° 29′.9.

Tobruk, 1914.—On level ground northeast of town, west of Italian cemetery, 153 paces west-southwest of west corner of morgue, approximately same distance west of front of chapel at north corner of cemetery, and about in line between morgue and radio station; marked by drill hole in top of limestone post 16 by 16 by 62, centimeters projecting about 8 centimeters above ground. True bearings: minaret of mosque, 57° 40′.4; semaphore, 241° 39′.0; cross on cemetery chapel, 260° 35′.5.

Tolmetta, 1914.—On sloping ground east of garrison, almost due north of northwest corner and 110 meters northwest of northeast corner of ruins of ancient Roman building; marked by drill hole in top of limestone post 18 by 21 by 80 centimeters with C. I. W. 1914 cut in top. True bearings: top of signal station on mountain top, 1° 09′.9; foot of flagstaff at artillery fort, 38° 52′.9; foot of flagstaff over commander's office, 90° 33′.4.

AFRICA.

EGYPT.

Alexandria, 1914.—Reoccupation of C. I. W. station of 1908, on coast about 7 miles northeast of Alexandria, and about 2 miles beyond Ramleh; marked by cement post projecting 65 centimeters above ground at time of reoccupation. True bearings: minaret of mosque Sidi Beshur, 19° 32′.7; spire on El Serai, Khedive's mother's palace, 38° 19′.5; left or outer tower of Khedive's palace El Mantaza, 4 kilometers, 230° 24′.6; tip of minaret of mosque El Mandara, 242° 45′.6. A secondary station was occupied 384 feet (117.0 meters) southwest of principal station on line toward spire on Khedive's mother's palace.

Barrage, 1914.—Approximately a reoccupation of station established by Survey Department of Egypt in 1908, on land belonging to Wakfs Administration, on an elevation slightly above surrounding cultivated ground, about 2 kilometers northeast of town of Barrage, east of road from Barrage to Bahada, southwest of canal, and nearly south of masonry bridge across canal; marked by tent-peg driven flush with ground. True bearings: spire on minaret on mosque at Barrage, 30° 33′.4; right edge at bottom of iron chimney at brick works, 91° 07′.0; center of brick chimney at pumping station, 303° 43′.0.

Barrani, 1914.—About 138 meters west-northwest of northwest corner of coast guard barracks, in line with north fence of barracks grounds, and about 35 meters due west of small masonry pier near northwest corner of fence; marked by drill hole in top of limestone post 15 by 15 by 60 centimeters, projecting 5 centimeters above ground. True bearings: apparent vertical leg of tripodal lighthouse, 142° 32′.2; flagpole north of coast guard office, 274° 33′.2; southwest corner of barracks, 310° 39′.9.

Daba, 1914.—About 200 meters south-southeast of coast guard station, near top of low rocky mound that stands out prominently from surrounding level land; marked by wooden peg in top of masonry pier 40 by 40 centimeters built on bedrock and projecting 15 centimeters above ground. True bearings: minaret of mosque at railroad station, 16° 51′.4; flagstaff at coast guard station, 153° 22′.2; southwest corner of coast guard watch-tower near coast, 177° 18′.0.

El Omeiyid, 1914.—On sandy desert about 200 meters northeast of railroad station; marked by drill hole in top of limestone post 15 by 20 by 75 centimeters, projecting about 10 centimeters above ground. True bearings: northwest corner of long stone building at depot, 40° 16′.7; flagpole on building belonging to a Greek, 2 kilometers, 72° 08′.4; tip of lighthouse on coast, 4 kilometers, 177° 13′.1.

Helwan Observatory, 1914, 1918.—Observations in declination and horizontal intensity were made on north pier in porch or absolute room of main observatory, designated *N*, and in hut about 46 meters southwest of observatory, designated *H*; observations for dip were made at *H* and on south pier in porch, designated *S*.

Khattara, Upper Egypt, 1918.—Close reoccupation of Egyptian survey station of 1909, about ¾ kilometer north of railway station, and about 300 meters east of railroad track, in wadi north of rocky hill and northeast of cemetery, 55 yards (50 meters) south of white-washed mud pulpit (mazbar), and about same distance north of small pile of stones; marked by large piece of reddish sandstone with rounded edges. True bearings: telegraph-pole nearest hill, 72° 13′.3; third telegraph-pole visible north of hill, 81° 13′.3.

Luxor, Upper Egypt, 1918.—Close reoccupation of Egyptian survey station of 1909, near west corner of

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EGYPT—*concluded.*

Luxor, Upper Egypt, 1918—continued. grounds surrounding Temple of Mut, on top of remains of ancient mud-brick wall, west of Temple of Mut, in line with northwestern edge of Temple of Rameses III, and 114 meters from its west corner; marked by tent peg. True bearings: flagpole on central part of American Mission building marked Girls' School, 62° 05′.4; northern corner of upper coping of eastmost pylon in Temple of Karnak, 223° 55′.6.

Matruh, 1914.—About 15 meters from water's edge at east end of harbor, northeast of town, on south side of harbor, and about 200 meters east-southeast of old Turkish fort; marked by drill hole in top of rough limestone post 18 by 18 by 65 centimeters, projecting 5 centimeters above ground. True bearings: minaret of mosque at west end of harbor, 73° 40′.8; signal pole at fort, 116° 38′.5; outer edge of corner tower at fort, 118° 23′.8.

Negeiyila, 1914.—About 4 kilometers east of village of Negeiyila, nearly south of Ishaila Rocks, and about 92 paces north of telegraph line; marked by drill hole in top of limestone block 18 by 18 by 40 centimeters, projecting 5 centimeters above ground. True bearings: south end of stone house in village, 94° 00′.2; west corner of stone house, 2 kilometers, 115° 47′.6; west end of smaller of Ishaila Rocks, 3 kilometers off shore, 162° 24′.9; east end of larger rock, 166° 09′.0.

Rail Head, 1914.—About 200 meters northeast of railroad station and a few paces south of prominent hill; marked by drill hole in top of limestone block 15 by 15 by 60 centimeters, projecting 5 centimeters above ground. True bearings: east corner of stone house on hill, 4 kilometers, 7° 02′.2; west corner of stone house on hill, 4 kilometers, 7° 14′.4; flagpole on hill, 1 kilometer, 122° 31′.4.

Sellum, 1914.—About 75 meters northwest of coast guard office, in center of square excavation apparently intended for a building; marked by tent-peg driven flush with ground. True bearings: flagpole on Turkish fort on mountain, 139° 57′.0; flagpole on small watch-house on hill, 297° 03′.6; flagpole on coast guard office, 313° 15′.0.

Suez, Lower Egypt, 1914, 1918.—Station of 1908 and 1911 was reoccupied; on low desert west of town of Suez, on embankment road leading southwest from town to Asiatic Petroleum Company, north of road, 116 meters north of small brick structure near navigation beacon on south side of road; marked by brass bolt 4.5 inches (11 cm.) long and 2 inches (5 cm.) in diameter at top, set in cement in top of sandstone post 20 by 25 by 80 centimeters, projecting about 5 centimeters above ground and finished off square with cement, the precise point being the intersection of cross cut in top of bolt. True bearings: mosque in Port Tewfik, 207° 39′.4; mosque of Ibrahim Bey Gilidan, 213° 54′.7; mosque of Abul-Eef, 238° 32′.3; mosque in Port Tewfik, 311° 20′.1; spire of Catholic church in Port Tewfik, 313° 13′.2. The sandstone post was found badly weathered in 1918.

A secondary station was occupied 300 paces northeast of main station in line toward minaret of Abul-Eef mosque, 12 paces south of southern boundary of golf-links; marked by tent-peg driven flush with ground.

Tor, Sinai Peninsula, 1918.—Close reoccupation of station of 1911, on sand spit opposite village and northwest of quarantine station and jetties, 225 paces west of large pile of oyster shells; marked by piece of three-quarter inch (2 cm.) board driven 0.5 meter into sand. True bearings: nearest corner of large building, 168° 48′.7; mosque in northwest part of Tor, 238° 22′.6; mosque in southeast part of Tor, 244° 30′.6.

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ERITREA.

Adi Caieh, 1914.—Reoccupation of Palazzo's station, about 200 meters west of commissariat building; marked by tent-peg driven flush with surface. True bearings: northwest corner of commissariat building, 247° 53′.8; minaret of mosque, 327° 27′.5; mountain peak, 336° 03′.7.

Agordat, 1918.—On eastern side of steep range of hills stretching out from southern mountains almost to river bed, near carved-out path leading down from old fort to commissaire's office, on nearly level space, 35 meters northwest of second turn in path from fort; marked by pile of loose stones. True bearings: peak of monument within fort, 10° 04′.0; post-office flagpole, 200° 01′.2.

Asmara, 1914, 1918.—Stations of 1914 and 1918 are close reoccupations of L. Palazzo's station. In public garden, at rear of governor's mansion, west of flagstaff on mansion, south of and directly opposite gate leading from road on north side of garden, and 10 meters north of edge of deep drainage ditch; marked by stake driven flush with ground. True bearings: time-ball staff in fort, 106° 52′.7; short wireless pole in fort, 109° 55′.4; tall wireless pole in fort, 117° 02′.2; signal pole in fort, 118° 49′.7; left corner of stone house, 212° 57′.9; flagpole on governor's mansion, 270° 08′.8.

Massaua, 1914, 1918.—Stations of 1914 and 1918 are close reoccupations of that of 1911, on south end of Taoualand Island, which is connected with Massaua Island by causeway, on that portion of island used as rifle range, between two firing platforms, 44 meters north of west end of south platform; marked by wooden peg. True bearings: cupola of New Hotel near post-office, 198° 02′.5; dome of commissioner's office, former governor's mansion, 199° 06′.4; mosque in Massaua, 224° 10′.7; Ras Mudir Lighthouse, 232° 48′.4.

FRENCH EQUATORIAL AFRICA.

Abakatal, Tchad, 1917.—Outside south corner of village, between village and oued, about 5 meters from nearest of ruined huts composing village. True bearing: spreading tree across oued, 7° 37′.6.

Abeché, Tchad, 1917.—Reoccupation of Tilho astronomical station of April 1917, just outside northwest corner of encampment inclosure, 12 meters north 30° west of piquet 27 of Abeché town surveys; marked by piece of native wood. True bearings: chimney-like formation of rock near northwest end of long high ridge, Piton Ouest, 101° 25′.6; Signal Nord, 186° 01′.1; Piton Est, 262° 01′.1.

Abou Tibené, Tchad, 1917.—In front of rest-houses, each composed of two round-walled huts joined by a rectangular room whose walls and roof are made of stalks of guinea-corn, 25 meters southeast of east house; marked by tent peg driven flush with ground. True bearing: peak of most northerly native hut in small village, 357° 30′.4.

Affoughly, Tchad, 1917.—In southern part of large encampment compound, 5 meters north of central point of thorn-brush barrier forming south side of compound; marked by tent peg driven flush with surface of sand. True bearing: peak of native hut in small village to south, 10° 59′.6.

Am Raya, Tchad, 1917.—Practical reoccupation of Tilho station of 1908, 360 meters southwest of group of wells at present in use, on gently sloping ground; marked by tent stake driven flush with surface. True bearings: center of tree by present well, 208° 01′; tree on opposite side of sink-hole, 222° 27′.6; old well, 224° 06′.

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FRENCH EQUATORIAL AFRICA—*continued.*

Ati, Tchad, 1917—South of and outside mud walls inclosing post buildings, in line with west face of old fort which forms southeast corner of post, and 25.0 meters south of its southwest corner; marked by tent stake driven flush with surface of ground. True bearings: southeast corner of fort, 240°.5; section of east wireless pole just above earth mound surrounding base, 282° 11′.2.

Ayemé, Gabon, 1916.—In village of Ayemé, which is surrounded by banana plantations and located on top of slight ridge in center of large clearing in forest, at a point near center of clearing and 5 meters east of pathway; marked by tent-peg driven flush with ground.

Baboko, New Cameroun, 1919.—Just north of Baboko, a village on left bank of Sanga River, about midway between Carnot and Bania, in middle of main road to Carnot, 46 paces up road from northwest corner of village, about 80 meters north of European rest-house, and about 50 meters from a large tree which bears 56° east of south. True bearings: post on west side of palaver house, 120 paces, 13° 21′.6; west gable end of European rest-house, 357° 49′.0.

Baibokoum, New Cameroun, 1919.—In about middle of large open space known as Place D'Armes, around which are grouped buildings of French government post, exactly in line with veranda posts along north side of travelers' house, 54.75 meters west of northwest veranda post and 44.80 meters northeast of southeast corner of rock foundation of residence of Chef de Poste; marked by large triangular-shaped block of granite, 1.1 meters at greatest length and 0.55 meter at greatest width, projecting 0.55 meter above surface of ground. True bearings: southeast corner of rock foundation of residence of Chef de Poste, 64° 54′.8; north peak of two conical peaks of range, 108° 07′.8; southwest corner of guard hut, 133° 47′.5; northwest corner post of sergeant's house, 244° 29′.2; northwest corner veranda post of travelers' house, 266° 34′.0; left side of end peak of range, 280° 04′.6.

Baleiniere, Tchad, 1917.—On high bank on right side of Chari River, in rest-house yard overlooking river, 7 meters southwest of wall of round, mud, straw-roofed rest-house; marked by stake.

Bangui, Oubangui-Chari, 1916.—Back of junction of Rue du Docteur Gureau with Rue Foureau-Lamy, on hill which is completely covered with very tall, cane-like growth; marked by monument the base of which extends 30 centimeters into ground, the exposed portion being composed of bricks plastered with cement, and top face lettered C. I. W. 1916, with cross cut to indicate exact center. True bearing: fork of spreading tree in Belgian Congo, 325° 26′.8.

Bania, New Cameroun, 1919.—At abandoned government post, northwest of orange tree at east end of short curved trench at north limit of post, near west edge of path leading to Hausa village, 80.25 meters northwest of northeast corner of building used as store, and 90 paces north of stone pillar under trees; marked by roughly rectangular shaped quartz rock, 10 by 25 by 50 centimeters, set so as to project about 0.15 meter above surface, and covered with cairn of quartz rock about 1 meter high. True bearings: south end of roof of chief's house at Hausa village, 0.4 kilometer, 137° 25′.2; east end of roof of chief's house at Baya village, 1 kilometer, 158° 06′.1; northeast corner post of store, 316° 03′.2; pillar, under trees, 341° 49′.

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FRENCH EQUATORIAL AFRICA—*continued.*

Bayanga, New Cameroun, 1919.—At abandoned French government post on left bank of Sanga River, 60.80 meters northeast of northwest corner of post residence, 42.15 meters north of northwest corner of brick tomb, and 8.50 meters southwest of prominent palm tree. True bearings: northwest corner of residence, 40° 07′.9; bottom of nearby palm tree, 231° 21′; northwest corner of brick tomb, 356° 16′.8.

Beguekai, New Cameroun, 1919.—In middle of main road from Goré to Baibokoum, 59 paces west along road from northwest corner of government encampment, and 22 paces south of large tree in bush. True bearings: tree in bush north of road, 186° 17′.7; top of European hut, in government encampment, 305° 02′.9.

Bi River, Oubangui-Chari, 1917.—On north side of road from Bangui to Fort Sibut, about 3 hours march northeast of nearest village, which is situated on banks of Ombella River, at edge of road, about 100 meters east of small foot-bridge over clear brook running over hard granite ledges and large boulders; marked by tent-peg. True bearing: mark on trunk of large tree 2 meters south of bridge, on west side of brook, 58° 28′.1.

Bir Taouil, Tchad, 1917.—Inside post, at a point southwest of office and northwest and in front of 3 lots set apart for houses of white officers, 45.56 meters southwest of south corner of fort, and 24.25 meters northwest of low wall around the 3 lots; marked by tent peg driven flush with surface of ground. True bearing: mountain peak, near short perpendicular edge, 340° 39′.6.

Bol, Tchad, 1917.—Close reoccupation of Tilho station of 1908, in inclosure formed by straw fence around rest-house, close to north gate in mud wall surrounding post buildings, and east of shelter erected by Captain Tilho for a meteorological station, 11.0 meters north of residence of sergeant in command of post, 9.3 meters east of east corner of thermometer shelter, 23.3 meters southwest of corner of rest-house, and 5.6 meters north of center of mud wall; marked by wooden stake driven flush with surface of sand. True bearings: small tree near edge of arm of lake, 168° 02′.8; point of hut, 228° 27′.9.

Bomassa, New Cameroun, 1919.—On left bank of Sanga River, at south end of native village, on property of C. F. S. O. trading company, 31.65 meters and 34.25 meters northwest of north and west corners respectively of residence for use of Europeans, 22.85 meters northeast of northwest corner of house for boatmen, and 14.75 meters from orange tree nearly in line with west corner of residence for Europeans; observations were made upon a stone pillar 35 by 35 centimeters standing 90 centimeters above ground, probably erected for astronomical observations. True bearings: northwest corner of house for boatmen, 33° 52′.8; north corner of residence for Europeans, 311° 41′.8; west corner of residence for Europeans, 329° 36′.8; orange tree in front of residence, 334° 17′.4.

Bongor, Tchad 1919.—Under small tree just outside north corner of large open space in front of residences of post, on right bank of Logone River, in continuation of line of hedge running past fronts of residences, 0.9 meter northwest of tree in hedge; to be marked by mud-brick pillar, 0.5 meter square and 1.25 meters high, its base about 0.5 meter below ground. True bearings: large lone tree across river, 3 kilometers, 12° 53′.4; large tree behind foundation for traveler's house, 60 meters, 300° 20′.4; top of flagpole, about 250 meters, 331° 21′.1.

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FRENCH EQUATORIAL AFRICA—*continued.*

Bouar, New Cameroun, 1919.—At French government post, in open space between flagstaff and market building, exactly in line with east edge of school building, and south side of market building, 20.42 and 22.30 meters from southeast and southwest corners respectively of school building, and 28.05 meters east of southeast corner post of market building; marked by rough rectangular-shaped block of granite 0.3 by 0.3 by 0.7 meter, top face being left 0.3 meter above surface of ground. True bearings: top of southeast corner rock foundation of southmost residence, 12° 48′.2; top of northwest corner rock foundation of traveler's house, 50° 14′.0; south edge of southeast corner post of market building, 70° 24′.3; bottom of southwest corner of school building, 135° 09′.1; bottom of southeast corner of school building, 159° 30′.0; flagstaff, 226° 01′.1.

Boudei, New Cameroun, 1919.—In middle of main road from Bouar, 76 paces east of west edge of clearing around first hut on south side of road encountered upon entering village from west, and 46 paces east of tall, scraggy tree in middle of road. True bearings: top of northwestmost hut of village, 70 meters, 78° 09′.8; tall, scraggy tree in midlde of road, 90° 20′.4.

Boué, Gabon, 1916.—On north bank of Ogoué River, on flat plain on which are situated government post and trading factories of Société du Haut-Ogoué, on property of Société concession, about 30 meters north of large ditch separating concession from government post, and 7 paces west of path to Société buildings at point 50 paces north of its junction with path from canoe landing-place up to post; marked by rough granite boulder, exposed part of which is painted red. True bearing: lone tree on plateau down stream, 128° 43′.1.

Boukiero, Middle Congo, 1916.—On right bank of Congo River, near Brazzaville, about half-mile (0.8 km.) over open grassy land from landing on river bank, on hill called Boukiero, former station of French Hydrographic Mission, at a point about 100 meters northeast of small wood crowning top of hill; marked by tent stake. True bearing: west wireless pole, 17° 03′.4.

Boukoussou, Gabon, 1916.—Part way up steep hillside forming right bank of Ogoué River, near path leading up from landing-place to village, which is situated on hillside about 20 meters above water, at a point on cleared space on first shelf on hillside, formerly occupied by native huts, about 10 meters above water.

Bousso, Tchad, 1917.—On right bank of Chari River, at place where telegraph line and road from Fort Archambault to Fort Lamy cross river, in north corner of inclosure containing rest-house, southwest of wooden stockade fence surrounding administration buildings and garden, 8 meters south-southwest of fence and in line with northwest face of post-office and telegraph-office; marked by pile of mud bricks. True bearing: telegraph pole on opposite bank of river, 286° 56′.8.

Brazzaville, Middle Congo, 1914, 1916.—Stations of June, July, and November 1916 are identical, and close reoccupations of that of 1914, in small park occupying triangular plot between road to plateau and river road to plain, in front of French Bank of Equatorial Africa, a few inches from south edge of walk parallel to plateau road, 21.6 meters east of nearest corner of brick monument on edge of plateau road, 21.92 meters north of similar one on river road, 38.60 meters north of steel plate at corner of brick monument marking bank property, 25.88 meters east-northeast of center

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FRENCH EQUATORIAL AFRICA—*continued.*

Brazzaville, Middle Congo, 1914, 1916—continued.
of fan-palm, 8.43 meters from mango sapling 2 inches (5 cm.) thick, and 1.5 meters from small oil-palm; marked by tent peg. True bearings: north corner of bank, 0° 52′.7; lamp-post, 232° 45′.0; gable end of white building across river in Kinshasa, 319° 03′.9.

Cape Lopez, Gabon.—See Port Gentil.

Carnot, New Cameroun, 1919.—At French government post, west of Camp de Militia, 5 paces south of edge of main road, 13.25 meters north of bottom of flagstaff, 4.80 meters from northmost point of ornamental star around flagstaff, 49.60 meters west of northwest corner post of interpreter's house; marked by rough stone approximately in form of triangular pyramid, 1 meter high and 1 meter across base, set with top projecting about 40 centimeters, and having a small brass rod set in top to mark exact center. True bearings: southeast corner of residence of adjoint to administrator, 150 meters, 60° 41′.2; southeast corner of brickwork of administrator's residence, 150 meters, 93° 18′.5; right side of brick pigeon-house, 70 meters, 121° 03′.4; northwest post of house of interpreter, 270° 36′.4; bottom of flagstaff, 342° 27′.

Chinchoua, Gabon, 1916—In flat, swampy country, south of tidal creek, on brow of hill, on grounds belonging to government post, at a point in front of administrator's residence, overlooking river, 34.27 meters north of northwest corner and 37.50 meters northwest of northeast corner, respectively, of residence, and 12.2 meters east of very large tree.

Damara, Oubangui-Chari, 1917.—On grounds of post, near top of small knoll, about 160 meters southwest of administrator's house and about 100 meters west of road, 43.5 meters northeast of northeast corner of small brick-walled, straw-roofed house, and 4 meters north of large outcropping rock about 1.5 meters in diameter, extending 0.5 meter above surface; marked by native reddish stone buried 20 centimeters in ground and projecting 25 centimeters above surface. True bearings: southeast corner of brick house, 22° 11′.0; southeast corner of veranda of administrator's house, 226° 49′.4; prominent tree reaching above sky-line, 298° 21′.6.

Dekoa, Oubangui-Chari, 1917.—On east side of road from Fort Sibut to Fort Crampel, just south of two mud rest-houses and southeast of market which is at junction of road from post-office with main road, at a point 30 paces from center of road and 109 paces southeast of southeast corner of market; marked by stake driven flush with ground. True bearing: northeast corner of northeast veranda post of brick residence of chief of subdivision, 120° 33′.0.

Deuguelba, Tchad, 1917.—On road from Mao to Moussou Morra, inside former inclosure of straw rest-house, and 25 meters south of southwest corner of rest-house; marked by tent-peg.

Diamené, Tchad, 1917.—On sandy plain covered with grass and small dune-palms, north of villages and also north of four wells in slight depression between barracks and villages, just west of soldiers' barracks and rest-houses, 13 meters west of mid-point in thorn-brush barrier on west side of rest-house inclosure; marked by tent-peg driven flush with ground. True bearing: peak of native hut in most westerly village, 43° 22′.2.

Diouma, Oubangui-Chari, 1917.—On grounds of post, east of road from Bangui to Sibut, on eastern edge of small plateau looking into valley, about 45 meters northeast of houses of French officials, 28 meters south of corner

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FRENCH EQUATORIAL AFRICA—*continued.*

Diouma, Oubangui-Chari, 1917—continued. of rest-house, and 15 meters north of bushy, good-sized tree; marked by stake.

Djambala, Middle Congo, 1916.—On grounds of post of Djambala, about 4 kilometers north of Batéké village of that name, near edge of plateau overlooking curious rock formations from 5 to 15 meters high, whose tops of harder sandstone are larger than the bases of softer stone, almost directly south of mud-walled, grass-roofed house of commander of subdivision, 90 paces south of flagpole, and 10 meters from edge of plateau; marked by squared piece of very soft sandstone projecting 5 centimeters above ground. True bearings: flagpole, 178° 12′.4; oil palm tree, 273° 26′.4.

Djambani, Middle Congo, 1916.—On right bank of Lekety River, just west of area containing commandant's house, market, and huts of soldiers, in line with south end of market, a roof without walls; marked by rough natural stone. True bearings: center post of south end of market, 233° 33′.1; tree on plateau, 330° 34′.0.

Djidodo, Tchad, 1917.—About 18 meters from north bank of Batha River, in southwest corner of rest-house inclosure, at junction of trails from Fort Lamy and from Mao and Moussou Morra to Ati; marked by tent stake driven flush with ground. True bearing: tall dune palm south of road, 79° 42′.8.

Djimmane, Tchad, 1919.—On right bank of Logone River, 112 paces southeast of entrance to government encampment at extreme south end of village, in middle of main path where it intersects remains of old mud wall, former east wall of village. True bearings: top of open-air pavilion in encampment, about 120 meters, 126° 35′.4; right end of roof of European hut, 135° 41′.6.

Djoumba, Oubangui-Chari, 1917.—On cleared ground surrounding mud-walled rest-house on hill southeast of road and telegraph line to Bangui and southeast of long foot-bridge over waterfall, at a point on hill near sharp descent into valley, 100 meters southeast of road, and 24.9 meters south of south corner of rest-house; marked by natural rough stone 10 by 20 by 25 centimeters, left 5 centimeters above surface of ground. True bearing: tree on distant ridge, 136° 20′.5.

Doba, Tchad, 1919.—In Place Publique, just southeast of mud market-building, and northwest of west gate of government post, 44.25 meters from southmost of two pillars of west gate of post, 39.15 meters east of large shady tree, 29.60 and 27.80 meters respectively from southwest and northeast corners of market building; to be marked by mud-brick pillar, 0.45 meter square and 1 meter high above surface of ground. True bearings: southwest corner of market building, 136° 10′.5; northeast corner of market building, 158° 33′.1; northwest corner of hedge on east side of Place, 80 meters, 216° 44′; bottom of southwest corner of southmost pillar of west gate of post, 305° 34′.3; top of south end of roof of government store, 90 meters, 324° 46′.4.

Fort Archambault, Middle Chari, 1917.—On left bank of Chari River, near monument in circle, surrounded by administration buildings of Middle Chari, 77.65 meters west of grand stairway leading down to river, 18.7 meters east of northeast corner of monument, and in line with its north foundation face; marked by tent peg driven flush with ground. True bearings: southeast corner of barracks, 103° 32′.6; southwest corner of government store's wall, 166° 11′.0; dead tree across Chari River, 229° 01′.0; northwest corner of office, 358° 49′.2.

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FRENCH EQUATORIAL AFRICA—*continued.*

Fort Crampel, Oubangui-Chari, 1917.—In cultivated field south of main road to Fort Sibut and north of hospital about 200 meters southeast of bridge over Gribingui River, 25 meters east of road from bridge leading to government buildings, and about 60 meters north of hospital; marked by tent peg driven flush with ground. True bearings: southeast corner of southeast veranda post of hospital, 11° 32′.7; northeast corner of northeast veranda post of doctor's residence, 327° 12′.6; flagpole in front of administrator's house, 333° 44′.4.

Fort Lamy, Tchad, 1917, 1919.—Three stations were occupied. Station *A*, occupied in 1917 and closely reoccupied in 1919, is nearly the same as Tilho station of 1908. Under large ficus tree known as "Commandant Lamy's tree" in front of lieutenant-colonel's residence, 7.6 meters from nearest part of tree which bears 215°.5 west of south, 28.7 meters southwest of west brick pillar at gateway in front of residence. True bearings: west palm of two at Kusseri, 0° 54′.0; near corner of colonel's house, 279° 47′.0.

Station *B* is on bank of Chari River about 200 paces northwest of station *A*, south of main road, southeast of club and buildings of Nana Trading Company, 30.45 meters and 27.85 meters respectively from east and south corners of fence around club. True bearings: south corner of residence opposite club, 190° 25′.7; left edge of Commandant Lamy's tree, 304° 24′.8; west palm of two at Kusseri, 358° 53′.6.

Station *C* is in a public area known as "La Place," 82.3 meters northwest of northwest corner of monument to Commandant Lamy, in line with southeast side of most westerly of three brick market buildings and 42.2 meters from its nearest corner, 75.4 meters west of south corner of east market building; marked by a red-brick pillar 45 by 45 centimeters and 125 centimeters high, having three grooves for instrument footscrews, and the letters C. I. W. cut in cement-covered top. True bearings: west end of roof of colonel's house, 0.4 kilometer, 8° 16′.5; east gable end of treasury building, 79° 26′.7; bottom of right leg of wireless tower, 123° 58′.5; northmost wireless mast, 154° 38′.3; bottom of nearest corner of most westerly market building; 218° 44′.9; bottom of south corner of east market building, 271° 38′.0; top of monument to Commandant Lamy, 334° 10′.4.

Fort Sibut, Oubangui-Chari, 1917.—Near northern end of large square on opposite side of road from houses of government officials, bounded on east by rows of rubber trees and on south by road to Bangui, at a point directly in front of house of chief of sub-division and 74.1 meters east of north brick post of steps leading up to it, 5.4 meters north of north edge of large circular flower-bed, and 15.0 meters north of small palm tree in center of flower-bed; marked by tent-peg. True bearings: north gable of special agent's house, 14° 59′.6; southeast corner of northeast veranda post of chief of circumscription's house, 37° 26′.3; southeast corner of house of chief of subdivision, 71° 55′.5.

Franceville, Gabon, 1916.—Close reoccupation of Bruel's station of 1911, and about 40 meters north of Mizon's station of 1882, just west of residences and offices of government officials, in line with south face and 54 meters west of southwest corner of quarters of special agent; marked by concrete monument 25 centimeters square extending 15 centimeters above surface of ground, and inscribed on top C. I. W. 1916, with cross cut to indicate exact point. True bearings: oil-palm tree on first ridge to south, 12° 23′.6; steeple of Catholic church, 164° 40′.1; northwest corner of quarters of special agent, 276° 37′.1; southwest corner of

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FRENCH EQUATORIAL AFRICA—*continued.*

Franceville, Gabon, 1916—continued.
quarters of administrators, 295° 44′.4; southwest corner of quarters of chief of subdivision, 318° 47′.6.

Gama, New Cameroun, 1919.—In extreme southeast corner of encampment near west side of main road from Baibokoum to Bouar opposite point where it is joined by road to nearby village of Doca, 21.80 meters south of nearer of two trees in front of hut for Europeans and 29.80 and 34.25 meters respectively from southwest and northeast posts of European hut. True bearings: southwest corner post of European hut, 144° 14′.9; northeast corner post of European hut, 162° 41′.6; nearer of two trees in front of hut, 164° 54′.7.

Goré, Tchad, 1919.—At French government post, near right bank of Penndé River, 30.85 meters south of large tree at top of steps leading down to river, 41.50 meters west of north side of large round hut of mud and thatch for use of travelers, 96.60 meters west of northwest corner of post residence, and 41 paces southwest of round mud dining-pavilion. True bearings: large tree at top of steps leading down to river, 199° 46′.2; top of dining-pavilion, 236° 36′.6; northwest corner of post residence, 261° 25′.8; north side of round hut for use of travelers, 281° 39′.2; south side of round hut, 300° 04′.6.

Goudjour, Tchad, 1917.—On road to Mao, on brow of ridge between two oueds and overlooking oued to east, outside rest-house inclosure between abandoned village and present village, 40 meters southeast of southeast corner of rest-house, and 100 meters south of trail to Mao; marked by wooden peg. True bearing: peak of hut in abandoned village, 106° 45′.5.

Hadjilidié, Tchad, 1917.—On east side of oued filled with dune-palm scrub and other trees with pond in center, near trail from Moussou Morra to Ati, in sand dunes, about 300 meters east of oued and 50 meters northeast of rest-house, a large square grass structure; marked by wooden stake driven flush with ground. True bearing: scrubby tree across oued, 102° 35′.6.

Haraze, Tchad, 1917.—West of fort and area of wells, just outside northwest corner of rest-house inclosure, about 170 meters west of fort, and 25 meters northwest of nearest rest-house; marked by tent peg driven flush with surface. True bearing: peak of native hut, 300 meters, 354° 36′.3.

Iki, Oubangui-Chari, 1917.—On right side of road from Dekoa to Crampel, near place where road bends and descends through village to N'Iki River, which is spanned by strong wooden bridge, 500 meters south of bridge, 10 meters east of road, and 50 meters northwest of crown of hill; marked by tent peg. True bearing: iron stake driven into trunk of tree, 148° 03′.4.

Irena, Middle Chari, 1917.—On west bank of Chari River and north of stockade surrounding rest-houses and gardener's house, 15 meters from bank, 20 meters northwest of northeast corner of stockade, and 30 meters southeast of large spreading tree; marked by tent stake.

Itinsi, Middle Congo, 1916.—At edge of very small, temporary, native village, on flat plain covered with brush and grass, about 1.5 hours' march from Lefini River.

Ivindo, Gabon, 1916.—About 125 meters southeast of Société du Haut-Ogoué factory and transport station on Ivindo Island, in grove of small coffee trees, at point 3 meters from edge of river bank and directly above rock in river bed nearly halfway between two

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FRENCH EQUATORIAL AFRICA—*continued.*

Ivindo, Gabon, 1916—continued.
reefs of solid rock, all of which are exposed at low water during dry season; marked by stake. True bearing: tree up-stream on opposite bank, 347° 09′.6.

Junckville, Gabon, 1916.—On right bank of Ogoué River, on left-hand side of path leading from canoe landing to factory of Société du Haut-Ogoué, at a point 3 meters from water's edge and 15 meters north of large tree to right of path. True bearing: tree on opposite bank of river, 60° 50′.1.

Kana, Oubangui-Chari, 1917.—About 4½ hours' walk from Bangui, on hill southeast of village, overlooking small cultivated plain, at a point about 50 meters northeast of highest point of hill, and about 200 meters south of road and telegraph-line to Bangui. True bearing: prominent tree on hill to east beyond small stream, 244° 25′.8.

Keliganga, Tchad, 1917.—In compound of rest-house on road to Mao, east of village, 7 meters southeast of center of road, and midway between northeast and southwest limits of compound; marked by wooden stake driven flush with ground. True bearing: lone palm, 157° 18′.2.

La Bassinda, Oubangui-Chari, 1917.—West of road to Sibut, in cleared area surrounding rest-house and a few native huts, about 60 meters west of road measured from a point about 180 meters south of wooden bridge over creek and 10 meters northeast of large, solitary, spreading tree; marked by tent peg.

Lai, Tchad, 1919.—In middle of La Place, a large open space just east of French government post of Béhagle, 79.2 meters and 70.5 meters northwest of northeast and southwest corner pillars respectively of market building, and 63.0 meters east of large tree; marked by brick pillar 0.45 meter square, standing about 1.25 meters above level of ground, with letters C. I. W. cut on side near top. True bearings: top of west end of roof of traveler's house, 120 meters, 29° 44′.6; north end of roof of lieutenant's house, 125 meters, 122° 05′.8; top of hut in southeast corner of camp, 120 meters, 189° 19′.7; bottom of northeast corner pillar of market building, 298° 27′.9; bottom of southwest corner pillar of market building, 319° 08′.7.

Lambarené, Gabon, 1916.—On right bank of Ogoué River, on beach of Hatton and Cookson Ltd., at a point 75.6 meters north-northeast of cement monument marking southeast corner of property of this company, and 1 meter from bank of river; marked by tent stake. True bearings: southeast corner of Hatton and Cookson Ltd. property, 23° 24′.1; southeast corner of administrator's residence, 28° 13′.1; tree with large spreading top across and down river, 347° 01′.3; small straight tree, 349° 31′.6.

Lastourville, Gabon, 1916.—About 500 meters west by a little south of Rouvier's station and about 75 meters southeast of Bruel's 1911 station, on left bank of Ogoué River, on grounds of post, almost in line between residence of administrator and cemetery on opposite hillside, and 100 paces southeast of residence; marked by brick and cement monument, two bricks square and two above surface of ground ,with foundation four times as large. True bearings: white tree on property of Société du Haut-Ogoué concession, 72° 36′.2; nearest corner of brick foundation of administrator's house, 114° 44′.5; prominent tree on hill across river, 212° 10′.2.

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FRENCH EQUATORIAL AFRICA—*continued.*

Libreville, Gabon, 1916, 1920.—Two stations, *A* and *B*, were occupied; *A* in 1916 and 1920 and *B* in 1916. Station *A* is in center of unoccupied plot of ground facing limestone quarry and beach and bounded on southwest by Boulevard de la République, 4 blocks southeast of market, at a point about 51 meters east of south corner of property of W. D. Woodin and Company, and 39.8 meters west of monument marking east corner, and 38.55 meters north of monument marking south corner, respectively, of plot; marked by concrete monument, 40 centimeters square and extending 20 centimeters above surface of ground. True bearings: largest of line of trees on distant point, 8 kilometers, 72° 43′.6; bottom of southeast brick pillar of building, 198° 54′.2; boundary pillar in east corner of plot, 290° 39′.1.

Station *B* is probably 1.5 kilometers or more south of Schwerer's 1895 station, within iron-fence inclosure of custom-house, east of small harbor, 12.5 meters west-northwest of fence and 18.3 meters east of large capstan; there was a quantity of magnetic material near this station. True bearing: old lighthouse on south pier, 58° 25′.8.

Lim, New Cameroun, 1919.—On south side of Lim River, in center of main road to Bouar, just over low stony ridge, 70 paces south of southwest corner of government rest-camp, and 127 paces along road from south bank of river.

Lito, Oubangui-Chari, 1917.—Two stations, *A* and *B*, were occupied. *A* is on left side of Gribingui River, about 100 meters from bank, in deserted French post, about 35 meters east of largest building, now rest-house, and 4 meters from northeast edge of cleared area; marked by tent peg driven flush with surface of ground.

B is in straw shed near house, 30 meters west of *A*.

Loango, 1915.—On Hatton and Cookson's property, about 85 meters northeast of fish store, in field of tall grass, 16.1 meters southeast of center of road leading up hill to post-office, and 41.3 meters north of east one of three trees growing together; marked by projecting point of large conglomerate stone. True bearings: north corner of convent veranda, 1° 09′.3; lighthouse, 73° 07′.1; Hatton and Cookson's flagpole, 81° 36′.3.

Logone Gana, Tchad, 1919.—Near middle of market place, on right bank of Logone River, southeast of government rest-house encampment, 12.6 meters southwest of right side of door to gate-house of mud-walled compound northeast of market place, 13.6 meters west of southwest corner of same compound, and 18.4 meters southeast of southwest corner of compound northwest of market place. True bearings: southwest edge of south building of rest-camp, about 40 meters, 121° 23′.1; southwest corner of compound northwest of market place, 138° 16′.7; bottom of right side of door of gate-house, 236° 20′.1; fork of large tree in southeast corner of market 10.2 meters, 327° 10′.2.

Mani, Tchad, 1917.—On right bank of Chari River, almost back of rest-house, about 20 meters south of market, and 20 meters from river bank; marked by wooden stake driven flush with surface of ground. True bearing: palm on opposite bank of river, 348° 34′.

Mao, Tchad, 1917.—Close reoccupation of Tilho station of 1908, among date-palm trees on western side of oued, which is a sink-hole between sand-dunes 1 mile (1.6 km.) long and half mile (0.8 km.) broad, about 600 meters east of center of post of Mao, 50 paces

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FRENCH EQUATORIAL AFRICA—*continued.*

Mao, Tchad, 1917—continued.
south of brick-kiln on southern side of excavation from which earth has been taken for post buildings, 33 meters south of nearest of cluster of seven date palms, and 12 meters north of nearest palm on south; marked by conical-shaped piece of soft light material, buried flush with surface of sand. True bearings: north edge of large square turret on residence and office of administrator, 89° 07′.7; date palm on opposite side of oued, 277° 11′.9.

Massanza, Gabon, 1916.—On left bank of Ogoué River, on property belonging to Société des Factoreries de Ndjolé, at a point directly in front of house of agent of company, in line of small oil-palms lining bank of river, and 7 meters from bank; marked by tent stake driven level with ground. True bearing: tree with long, bushy, cylindrical top on opposite side of river, 94° 09′.3.

Mayama, Middle Congo, 1916.—On grounds of poste, 236 paces west of Djoué River, measured from point where wire cable is stretched across for ferry, almost north of temporary straw residence of Chef de Subdivision, and 85 paces northeast of nearest oil-palm tree back of house; marked by irregular blackish stone left 3 inches (8 cm.) above ground.

M'Boma, Gabon, 1916.—At landing-place on right bank of Ogoué River, about 1 mile (1.6 km.) from village, in center of path leading up from landing, and 10 meters from water's edge at low water.

Milé, Tchad, 1917.—On right bank of Chari River, southeast of very small village of Milé, 75 meters southeast of market, and 10 meters from edge of bank; marked by tent peg. True bearing: iron stake driven into trunk of tree below market, 99° 36′.2.

Miltou, Tchad, 1917.—On left bank of Chari River, in mud-wall inclosure, on right-hand side of path leading from west gate toward village, 11.5 meters north of center of path, 72 meters west of wall in front of post-and-telegraph-office, and almost in line with north face of post-office; marked by brick monument 36 by 36 centimeters square, and 4 bricks above surface of sand. True bearing: northwest corner of post-and-telegraph-office, 261° 37′.6.

Missoko, Gabon, 1916.—On right bank of Ogoué River, at small village of Missoko, considered first day's stopping-place below Lastourville, on cleared space north of path leading up from river, 5 meters from river at high water; marked by tent stake. True bearing: portion of tree trunk between two prominent branches, on opposite side of river, 344° 41′.

Mogroum, Tchad, 1917.—On left bank of Chari River, north of post inclosure, and northeast of market, a small straw-covered shed, in center of road to native village, 33.55 meters northwest of northeast corner of post wall, 31.30 meters north of nearest point on wall, and 19.2 meters east-northeast of center of tree at north end of market; marked by tent peg.

Moloundou, New Cameroun, 1919.—On property of Ngoko-Sanga Trading Company, on right bank of Ngoko River, about 1 mile (1.6 km.) west of French government post, at extreme northeast end of property, in east corner of sheep paddock, 23.40 meters and 33.55 meters from east and north corner posts respectively of fence around sheep-paddock. True bearings: south end of roof of nearest of two large sheds, 70 meters, 73° 45′.1; northeast corner of goat shed in paddock, 101° 17′.8; southeast corner post of eastmost house on opposite bank of river, 142° 43′.8; north corner post of sheep-paddock fence, 144° 53′.6; southeast corner post of sheep-paddock fence, 294° 45′.2.

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FRENCH EQUATORIAL AFRICA—*continued.*

Mourra, Tchad, 1917.—Between west outer wall and west high, inner wall inclosing old residences of former Sultan of Ouadai, now used as encampment, at a point southwest of gate of inner inclosure, about 50 meters southeast of outer gate, 33 meters west-northwest of southwest corner of inner wall, and 21 meters west of large tree ; marked by rough native stone left nearly level with surface of ground. True bearing: peak of native hut on hillside outside of wall, 68° 44′.6.

Mousgoum, Tchad, 1919.—In northwest corner of government rest-camp, on low hill about 1 mile (1.6 km.) south of Mousgoum and just north of small village of Mirbedim, 5 paces east of bank of Logone River, 7.6 meters southwest of right side of doorway of west hut in a row of small huts along north side of encampment, 45.64 meters west of northeast corner and 48.70 meters northwest of southwest corner of European rest-house, 26.3 meters northwest of large tree west of rest-house. True bearings: top of left highest point on distant hill, 25 kilometers, 81° 51′.8; bottom of northeast corner of European house, 281° 22′.5; bottom of southwest corner of European house, 299° 37′.0; bottom of right edge of large tree, 71.75 meters, 317° 38′.4.

Moussou Morra, Tchad, 1917.—On level ground between post buildings and native market north of post, 81.9 meters north of northwest corner of office of subdivision, and 23.9 meters southeast and 27.5 meters east-southeast respectively of two trees; marked by tree trunk 20 centimeters in diameter, buried 75 centimeters in sand and surrounded by mud bricks. True bearings: tree across oued, 97° 56′.0; flagpole on fort, 330° 12′.5.

Moyo Combo, Middle Chari, 1917.—On sand-bank on east side of channel at low water of Chari River, about 500 meters north of rest-houses on high bank. True bearing: east edge of largest rest-house, 359° 04′.9.

M'Pala, Middle Congo, 1916.—South of forest on bank of Nkié River, about one-fourth mile (0.4 km.) north of residence of commander, and 50 paces from crest of ridge, looking down on post of M'Pala; marked by blackish natural stone left 5 centimeters above surface of ground. True bearings: tree, 7° 53′.6; perpendicular edge of rock, 18° 00′.6; most distant perpendicular edge of rock, 42° 43′.6; highest short perpendicular edge east of ridge terminating in small peak, 167° 46′.9.

Mussak, Tchad, 1917.—Between trail to Abeché and oued, 20 meters west of encampment composed of five small, temporary, wall-less huts near southern end of a long, sandy, cultivated ridge. True bearing: chimney-like peak on north end of long rocky ridge, "Piton Ouest" in town surveys and triangulation, 253° 05′.4.

Ndjolé, Gabon, 1916.—About 300 meters north of Bruel's station, on right bank of Ogoué River, on small hill, just north of government post, at a point 35 meters west of telegraph line to Libreville; marked by irregular stone. Rouvier's station was probably on island where old post was located.

N'Galo Billani, Tchad, 1917.—About 7 kilometers east of N'Galo Houmaguinda, on path leading from village to well in oued, about one-fourth of total distance from village, and 7 meters south of large spreading tree; marked by tent-peg driven flush with surface of sand. True bearing: peak of native hut on opposite side of oued, about 2 miles (3 km.), 10° 30′.4.

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FRENCH EQUATORIAL AFRICA—*continued.*

N'Gobo, Gabon, 1916.—About 2 hours' travel down north side of divide into basin of Ogoué River, about half mile (0.8 km.) above junction of the Passa River with smaller stream, in clearing of small native village of N'Gobo surrounded by small bushy trees and elephant grass.

Ngoïla, New Cameroun, 1919.—At government post of Fort Soufflay, in about middle of Place D'Armes, a large open space southwest of European residences of post, 94.50 meters southwest of west post of guard hut, 49.05 meters south of south corner of fence around sergeant's house, 40.50 meters north of north corner of north dormitory building, and 27 paces from main road; marked by brick pillar, 0.35 by 0.40 meter, 0.60 meter high, with base 0.55 by 0.60 meter, sunk 0.35 meter below ground. True bearings: northwest corner post of house in west corner of Place, 150 meters, 56° 38′.4; south corner of fence around sergeant's house, 194° 09′.7; west post of guard hut, 218° 45′.0; flagstaff at post, 200 meters, 228° 09′.2; near gable end of C. F. S. O. factory, 400 meters, 270° 07′.8; north corner post of north dormitory building, 358° 07′.9.

Ninth Encampment North of Fort Archambault, Tchad, 1917.—On sand-bar on right of low-water channel of Chari River, about 1 mile (1.6 km.) from village of Ouayi.

Niom, Tchad, 1917.—On high ground on right bank of Chari River, from which hills of Togbao, on opposite side of river and several miles up-stream, are plainly visible, south of grove of thorn trees between groups of native huts, and just south of slight depression in ground, 20 meters northwest of market, a straw-roofed shed, and 10 meters from edge of river bank; marked by tent peg. True bearings: palm tree across river, 96° 17′.8; rock on top of low point of Togbao Hills nearest river, 328° 27′.8; second low point of Togbao Hills, 328° 53′.8.

Nola, New Cameroun, 1919.—Two stations were occupied at government post. Station *A* is in about middle of open space just south of market inclosure, near landing place on right bank of Sanga River and north of administrator's residence, 91.00 meters northeast of northwest corner of administrator's residence, 34.90 meters southeast of southeast corner post of market building, and 22.55 meters northwest of tree at north side of gap in hedge. True bearings: northwest corner of administrator's residence, 18° 19′.3; southeast corner of foundation of residence, 100 meters, 102° 46′.6; southeast corner post of market building, 155° 57′.5; north end of roof of northmost of two residences across river, 0.5 kilometer, 266° 04′.3; tree on north side of gap in hedge, 314° 16′.9; flagstaff on river bank, 340° 56′.7.

Station *B* is in middle of large open space in Camp de Militia, surrounded by huts for soldiers, 72.45 meters northwest of northwest corner of adjutant's house, and 55.05 meters west of northwest post of guard hut; marked by brick pillar 0.42 meter square and 0.75 meter high, left projecting 0.50 meter above surface of ground. True bearings: cross on middle tomb of three in cemetery, 84° 20′.3; northwest corner post of guard hut, 291° 14′.0; northwest post of adjutant's house, 330° 04′.3.

Ouala, Gabon, 1916.—In village of Ouala, on crown of hill which is covered with forest up to edge of village, in center of common, an open space about 35 meters wide and half mile (0.8 km.) in length, on both sides of which are rows of native huts in single file, 20 paces south of market; marked by stake driven flush with surface of sand.

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FRENCH EQUATORIAL AFRICA—*continued.*

Ouesso, Middle Congo, 1919.—In south corner of manioc plantation belonging to civil guards of government post, near west end of Rue Goujon and just west-northwest of cemetery, at a point exactly in line between large camwood tree at intersection of Rue Goujon with street forming west side of manioc plantation and large fromager tree to north, 44.0 meters north of camwood tree, and 26.20 meters northwest of center of Rue Goujon; marked by brick pillar about 40 centimeters square, left 0.75 meter above surface of ground; a large cross, with figures 1919 above it, was deeply cut in camwood tree. True bearings: nearby large camwood tree, 44.0 meters, 8°; large fromager tree, about 90 meters, 188°; right end of roof of doctor's house, 320 meters, 254° 08'.6; top of northeast veranda post of residence of director of C. F. S. O., 430 meters, 266° 42'.8; top of right edge of wall of upper story of residence, 269° 57'.3.

Pangala, Middle Congo, 1916.—On top of large low mound, evidently an artificial construction, north of post-office, east of rubber drying house and quarters of postmaster, and about 150 paces north of brick residence of Commandant; marked by large blackish boulder left 3 inches (8 cm.) above surface of ground. True bearing: trunk of tree extending above surrounding bush, 118° 29'.6.

Port Gentil (Cape Lopez), Gabon, 1915, 1916, 1920.—Station established in 1915 and reoccupied in 1916, is on swampy open ground southwest of property of Hatton and Cookson and northwest of property of "Chargeurs Réunis," 29.7 meters west of center of cement walk through town; marked by concrete monument extending 1 meter below surface and 1 meter square, into which is set a concrete block 20 by 20 by 50 centimeters, extending above surface of ground and foundation concrete about 10 centimeters, top of which is marked C. I. W. 1915, a small bronze pin cemented into center of block indicating exact point. True bearings: Cape Lopez navigation-mark, 43° 22'.7; west gable of Hatton and Cookson warehouse, 245° 22'.7; north gable of "Chargeurs Réunis," residence, 276° 55'.8; windmill, 341° 03'.0.

Station occupied in 1920 is about 50 meters north of C. I. W. station of 1915 and 1916, 29.0 meters west of center of raised cement walk running length of town, and 9.25 meters southeast of path from native village joining cement walk near its north end. True bearings: large pyramid used as navigation-mark, 2 kilometers, 41° 20'.5; south gable of S. F. N. building, about 250 meters, 217° 21'.4; west gable of Hatton and Cookson's warehouse, about 200 meters, 257° 09'.6; north gable of "Chargeurs Réunis" residence, 0.4 kilometer, 283° 18'.0; flagstaff visible above trees, 1 kilometer, 334° 41'.2.

Roumbou, Tchad, 1917.—On trail to Ati, inside encampment inclosure, near southwest corner of thorn-brush barrier, 15 meters northeast of corner, and 2.5 meters from south side of barrier; marked by tent-peg driven flush with ground.

Second Encampment North of Fort Archambault, Middle Chari, 1917.—On sand-bar on right side of main channel of Chari River, at low water, about 300 meters from high bank. True bearing: prominent tree in bush on opposite side of river, 14° 32'.6.

Second Encampment North of Fort Crampel, 1917.—On Gribingui River, 30 hours' barge travel from Fort Crampel, on left bank of river, 150 meters from water's edge.

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FRENCH EQUATORIAL AFRICA—*concluded.*

Sembé, New Cameroun, 1919.—At French government post, near middle of large open space surrounded by buildings of post, 105.0 meters southeast of flagstaff, and 58.8 meters northeast of northeast corner of store; marked by square pillar of mud bricks, about 0.30 meter square, standing 0.25 meter above ground. True bearings: northeast corner post of store, 69° 11'.0; left side of flagstaff, 134° 42'.9; northeast corner of building used as hospital, 100 meters, 157° 20'.6; northwest corner post of north barracks, 242° 22'.6; southwest corner post of southmost barrack building, 120 meters, 299° 15'.5.

Sixth Encampment North of Fort Archambault, Tchad, 1917.—On sand-bar on left side of channel at low water of Chari River, 15 meters from main river bank. True bearing: solitary palm tree down stream, 146° 50'.6.

Souanke, New Cameroun, 1919.—At French government post, in middle of square forming European quarter, on pathway from flagstaff to store, northeast of its intersection at right angles with a second path across square, 54.65 meters southwest of flagstaff, 30.4 meters southwest of west corner post of sergeant's house, and 29.5 meters south of south corner post of residence of Chef de Poste; marked by brick pillar about 0.4 meter square, left about 0.5 meter above ground. True bearings: east post of store, 30 meters, 20° 50'; south corner post of residence of Chef de Poste, 190° 15'.0; flagstaff, 218° 18'.2; west corner post of sergeant's house, 241° 00'.8.

Tountouma, Tchad, 1917.—About 150 meters southeast of fort, south of fortified tetta, and northwest of large village and market, in small grassy basin surrounded by large rocks forming top of hill around base of which a small stream flows from spring, at a point nearly in line with spring and tetta, 7 meters from fair-sized branching tree, and about 2 meters south of center of basin; marked by tent-peg. True bearing: trunk of large solitary tree on low hill, 303° 26'.0.

FRENCH SOMALILAND.

Jibuti, 1914, 1918.—Station of 1918 is a close reoccupation of that of 1914, on waste ground north of Ambouli Gardens, 3 kilometers south-southwest of town of Jibuti, 54 meters east of center of road measured from point 4 meters north of 3-kilometer post, and 52 meters east of this post, which is a portion of a steel "I" beam mounted in a square masonry base on east edge of road; marked by a block of lava-like stone with oblong base and whose upper face is an acute triangle pointing northward. True bearings: lighthouse (Phare de Hayabile), 29° 49'.9; flagpole in front of governor's mansion, 201° 05'.5; mosque, 210° 26'.4; east wireless pole, 218° 13'.0.

FRENCH WEST AFRICA.

Abidjan, Ivory Coast, 1914.—About 1 mile (1.6 km.) north of wharf and government warehouse, in park east of lagoon and west of railroad, almost due west of house occupied by director of railways as office and residence, 60 feet (18.3 meters) northwest of an oil-palm tree, at end of path where wooded descent to lagoon begins; marked by tent-peg.

Bouaké, Ivory Coast, 1914.—About 1½ miles (2.4 km.) west of railroad station, and 150 feet (45.7 meters) west-northwest of carriage gate through mud wall inclosing buildings of Administration, and about in line with south side of road leading straight northwest from gate; marked by tent-peg.

AFRICA.

FRENCH WEST AFRICA—*concluded.*

Conakry, French Guinea, 1914.—Approximately 2.2 kilometers west of the C. I. W. station of 1912, on a strip of ground between Boulevard Circulaire and seashore opposite Treasury, 14 inches (35.5 cm.) south of extension of curb line along north side of lane leading from steps to Treasury, 45.6 feet (13.90 meters) west of west side of Boulevard Circulaire, 80 feet (24.4 meters) north of north end of seawall, and 55.1 feet (16.79 meters) south of a large palm tree. True bearings: triangulation monument on farthest visible point of island, 92° 59′.3; triangulation monument by boulevard erected in 1906 by Conakry Topographic Department, 199° 00′.0.

Dimbokro, Ivory Coast, 1914.—North of railroad and west of administrator's house, 100 feet (30.5 meters) southwest of a point 250 feet (76.2 meters) west-northwest of southwest corner of the house, and in line with its south side; marked by wooden stake.

Grand Bassam, Ivory Coast, 1914.—On north side of lagoon, 158 feet (48.2 meters) north of water's edge, 123 feet (37.49 meters) northeast of east end of small wooden foot-bridge, and north-northeast from concrete market building with tile roof; marked by wooden stake. True bearings: flagpole at government wharf, 31° 26′.2; flagpole of Chargeurs Réunis Steamship Company, 42° 16′.2; flagpole, 343° 53′.1.

Lome, 1914.—Southwest of custom-house, 725 feet (221.0 meters) west of railroad on wharf, and 17 feet (5.2 meters) south of south edge of road which runs parallel with beach; marked by piece of old concrete survey monument found by side of the road. True bearing: flagpole on post-office, 247° 03′.6.

Palime, 1914.—5 miles (8 km.) south of Misahöhe, and 1 block east of market, 9 feet (2.7 meters) east of line of trees on east side of main portion of road, 220 paces northwest of west end of cement bridge over drainage ditch which runs along east side of road; marked by tent peg. True bearings: steeple of Roman Catholic church, 85° 11′.5; east edge of railroad water tanks, 322° 25′.0.

GOLD COAST COLONY.

Accra, 1914, 1919.—Station *1914* is on golf links about midway between beach and main road between Accra and Christiansborg, 60 feet (18.3 meters) west of center of road leading from main road to sea, and south of police-guard room standing at intersection of these roads; marked by small concrete pier. True bearings: flagpole on custom-house at port, 49° 43′.8; flagpole of Accra Lighterage Company, Woermann agents, 55° 48′.5; flagpole of Bassel Mission factory, 60° 26′.1; steeple of Church of England, 64° 55′.4; steeple of Bassel Mission church, 69° 51′.3; steeple of church in Christiansborg, 234° 57′.9.

Station *1919* is near northeast corner of golf links, exactly in line with fence east of first bungalow east of Secretariat building, and 230.5 feet (70.25 meters), southeast of fence corner. True bearings: top of church steeple, three-fourths mile (1.2 km.), 50° 44′.6; vane on tower of post-office, three-fourths mile (1.2 km.), 61° 15′.2; eastmost gable of Secretariat building, 700 feet (213 meters), 99° 46′.6; east corner of fence around bungalow, 154° 28′.9; eastmost spike on white building, 400 feet (122 meters), 182° 29′.5.

Dunkwa, 1914.—West of railroad and south of road to district commissioner's bungalow, 143 feet (43.6 meters) west of rest-house, and 30 feet (9.1 meters) south of center of road. True bearings: staff on bungalow of district commissioner, 101° 50′.3; point on west gable of factory in village, 349° 29′.5.

AFRICA.

GOLD COAST COLONY—*concluded.*

Elmina, 1914.—Reoccupation of U. S. Coast and Geodetic Survey station of 1889, near Fort St. George, on eastern end of reef forming harbor of Elmina, about 7 miles (11 km.) east of Cape Coast Castle, 108 feet (32.9 meters) southeast of seawall along north side of road, 180 feet (54.9 meters) southwest of wall embankment on west side of paved road along southwest side of fort, and 117.5 feet (35.82 meters) southwest of cement monument, 1 by 1 by 3 feet (30 by 30 by 91 cm.), roughly lettered C. G. S. and marking northeast corner of open public ground. True bearings: flagpole on San Iago Prison, 145° 42′.8; flagpole on Fort St. George, 251° 53′.8.

Station *B* is 292.0 feet (89.00 meters) southwest of main station, *A*, in extension of azimuth line from steel telegraph-pole (211° 57′.5), 4 feet (1.2 meters) east of a palm tree, and 20 feet (6.1 meters) from water's edge.

Kpandu, 1914.—Between market and residency, 35 feet (10.7 meters) south of center of road, and 36 feet (11.0 meters) east of a point in line with east side of rest-house and 6 feet (1.8 meters) from northeast corner of cement floor of porch; marked by tent peg. True bearing: steeple of Catholic Mission church, 262° 23′.9.

Kumasi, Ashanti, 1914.—In polo ground south of railroad and village, and west of rubber plantation, 6 feet (1.8 meters) from nearest point of an 8-foot (2.4-meter) embankment along northeast side of grounds, and about midway between southeast and northwest ends of the grounds, at head of small ravine which descends toward village. True bearings: chief commissioner's flagpole on small parade ground near post-office, 178° 22′.8; flagpole on building at fort, 189° 32′.3; cross on Bassel Mission church, 196° 18′.3.

Sekondi, 1914, 1919.—Station *1914* is on top of gravel pile on eastern edge of area dug over by gold miners, on top of ridge northeast of harbor and east of branch railroad; marked by tent-peg.

Station *1919* is on top of low red cliff, about 600 feet (183 meters) south of lighthouse, about 400 feet (122 meters) east-southeast of High Court building, at a point exactly in line with fence southwest of ordinary courthouse building and 66 paces southeast of its south corner. True bearings: center of window of red-roofed bungalow on hill, 1 mile (1.6 km.), 79° 47′.9; left gable end of white house through palm trees, half mile (0.8 km.), 100° 25′.7; westmost gable of High Court building, 115° 50′.9; southwest corner of fence around courthouse, 149° 11′.9; vane on lighthouse, 182° 03′.2.

LIBERIA.

Cape Palmas, Russwurm Island, Maryland County, 1914, 1919.—Station of 1919, which is a close reoccupation of C. I. W. station of 1914, is on level space on rocky ridge, 6 feet (1.8 meters) south of southern extremity of large rock, about 3 feet (0.9 meter) above ground, about 10 feet (3 meters) north of Grebo burial place, about 20 feet (6 meters) north of small hut built over bushes, and practically in line with east side of Woodin and Company's house extended southward; marked by chipping in north face of rock, the letters C. I. W. 6′ S. True bearings: bottom of tip on lantern of lighthouse at Cape Palmas, 128° 23′.4; Woermann light-standard to hold lantern on Woermann house, 176° 46′.1; middle of gable on front of Woermann house, 177° 06′.2; west gable of Masonic building, 217° 07′.6; east spire of new Episcopal church, 236° 32′.7.

AFRICA.

LIBERIA—*concluded.*

Cuttington, Maryland County, 1919.—On grounds south of Epiphany Hall, east of footpath, 223 feet (68.0 meters) from southwest corner and about 327 feet (100 meters) from northwest corner of Hall, 84 feet (25.6 meters) northeast of center of middle one of three mango trees, and 33.3 feet (10.15 meters) south of stub of coffee tree in line with nearest corner of Hall. True bearings: tree in saddle of hills, 161° 35′.6; northwest corner of Epiphany Hall, 127° 54′.0; small rock islet in distant sea, 301° 45′.3.

Harper, Maryland County, 1919.—In a cleared field, about 80 yards (73 meters) north of north beach of river entrance, approximately in line with north side of stone station-house of water-police, and with fore- and after-masts of stranded "Yaroba", about 165 yards (151 meters) west of northwest corner of station-house and about same distance from "Yaroba;" 41 feet (12 meters) northwest of stub of bread-fruit tree, 104 feet (31.7 meters) northeast of nearest tall coconut tree, 69.5 feet (21.18 meters) south of middle stem of a 3-stemmed bread-fruit tree, and 105 feet (32.0 meters) southwest of a large bread-fruit tree; marked by tent-peg driven flush with ground. True bearings: east gable window of Woodin and Company's house (Villa Deborah), 5° 04′.5; west gable window of Woodin and Company's house, 5° 14′.5; bottom of tip on lantern of lighthouse at Cape Palmas, 14° 26′.5; bottom of after-mast of stranded "Yaroba" on north beach, 114° 33′.5; northwest edge of water-police station-house, 307° 18′.5; north gable of Senator H. Too Wesley's house, behind flagpole, 320° 31′.3; west gable of Masonic Hall, 335° 50′.0.

NIGERIA.

Abinsi, Muri, 1914.—On bushy land south of swamp and southwest of military commander's and district officer's bungalows, at edge of rifle range near 100-yard bunker, 10 yards (9 meters) nearer targets than first shooting platform, and 12 feet (3.7 meters) west of drainage ditch along edge of range; marked by a large wooden stake. True bearing: flagpole in front of fort, 171° 58′.1.

Abol, Central Province, 1914.—East of Niger River, west of brick court-house and other buildings, on elevated piece of ground containing old garden, rectangular concrete water-tank and tennis court, near raised path running parallel to river, 47.0 feet (14.33 meters) west of nearest point in concrete gutter surrounding garden, 66.5 feet (20.27 meters) west-northwest of northwest corner of water-tank, 76.5 feet (23.32 meters) north-west of northwest corner of tennis court proper, 144 feet (43.9 meters) northwest of well, and 28 feet (8.5 meters) southeast of only wild tree; marked by pier of old sundial, a concrete block 1 by 1 by 3 feet (30 by 30 by 91 cm.), with finished paneled sides, embedded 2 feet (61 cm.) in sand, its top surface rough and broken, an irregular hole from which steel reenforcement bar had been removed extending lengthwise through middle. True bearings: distant tree across river, 170° 29′.0; south gable of Niger Company's bungalow, 235° 18′.3.

Amar, Muri, 1914.—Near water's edge at low water on a sandy beach, at Amar, a deserted village surrounded by large swamps, at one time provincial headquarters of government.

Baro, Niger, 1914.—East of Niger River and southeast of native village, on flat top of steep Baro Hill, just outside cleared area of bushland, east of golf links and houses and offices of army, police, marine, and political officers, occupying western part of top of hill near river, 35 feet (10.7 meters) east of large tree; marked by a tent-peg. True bearing: flagpole in front of house occupied by marine and transport officer, 102° 04′.0.

Bauchi, Central Province, 1914.—On grounds of government of Bauchi District, about 2 miles (3 km.) west of native town, about 200 yards (183 meters) south of brick iron-roofed house of military officer, and in line with its east face, and 250 feet (76 meters) west of west entrance of mud straw-roofed house of assistant district officer, which is one-fourth mile (0.4 km.) west of post-office and mud courthouse; marked by a tent-peg.

Debba Habe, Central Province, 1914.—On hill half mile (0.8 km.) northwest of village, 90 feet (27 meters) southeast of front entrance of rest-house building, a large 3-roomed, mud structure surrounded by a veranda and covered with a straw roof; marked by a tent peg. True bearing: papaw tree in village, 321° 28′.3.

Forcados, Central Province, 1914.—On north shore of island immediately west of Forcados, formerly occupied by native government clerks and known as Pigeon Beach, about 2 miles (3.2 km.) by boat from Elder Dempster wharf in Forcados, at a point 70 feet (21.3 meters) southeast of water's edge at high tide, and 700 feet (213 meters) southwest of old well; marked by a tent-peg. True bearings: gable of telegraph building at end of cable, 140° 30′.6; flagpole near post-office, 254° 26′.5.

Ibadan, Southern Nigeria, 1914.—North of railway depot, north of the main road where it changes its course from west to northwest after crossing tracks just north of side tracks on curve, and opposite point where main road is joined by road from south which, after turning sharply toward southeast, passes offices, bungalows, and rest-houses of railroad men, and terminates at railroad, about 150 feet (45.7 meters) north of depot; 45 feet (13.7 meters) north of center of main road, 105.5 feet (32.16 meters) southeast of large cotton tree at edge of main road, 104.5 feet (31.85 meters) northwest of cotton tree in angle of hedge on opposite side of main road; marked by fragment of concrete slab, 4 by 8 by 8 inches (10 by 20 by 20 cm.) burried flush with surface of ground. True bearings: southeast gable of railroad rest-house, 2° 05′.5; finial on south gable of bungalow north of railroad rest-house, 18° 22′.5; center one of three palm trees standing alone, 245° 16′.0.

Ibi, Muri, 1914.—On property of Sudan United Mission on south edge of native quarter of Ibi, bounded on north by a street, on west by a raised road, and on south by cultivated fields south of which a swamp drains northeast into river close to southwest corner of mission property, 24.8 feet (7.56 meters) north of small angle-iron buried in a cement block marking southwest corner of mission property, and about 3 feet (0.9 meter) east of west boundary; marked by a tent-peg driven flush with ground. True bearings: southwest corner of mission property 3° 15′; point T_3 of Government surveyor's transit traverse, 74° 22′.9; wooden flagpole in front of doctor's bungalow, 83° 32′.9; steel flagpole in front of provincial resident's house, 95° 34′.9.

Idah, Central Province, 1914.—On high bluff overlooking Niger River, north of native village, trading company canteens, and house and office of government political officer, 120 feet (36.6 meters) northwest of mud-walled, straw-roofed rest-house, and 20 feet (6.1 meters) east of edge of bluff; marked by a tent-peg. True bearing: prominent tree across river, down stream, 55° 11′.7.

AFRICA.

NIGERIA—*continued.*

Ilorin, 1914.—Near deserted government station about 2½ miles (4 km.) northeast of railroad station, 250 feet (76 meters) northeast of northeast corner of rest-house, and 35 feet (10.7 meters) east of center of road, opposite beginning of sharp bend to northwest; marked by irregular reddish stone buried flush with ground.

Jebba, 1914.—On hill nearest south end of railroad bridge being constructed across river, at northwest corner of intersection of two paths on top of hill, 20 feet (6.1 meters) west of center of north-and-south path and 35 feet (10.7 meters) north of center of path running approximately eastward to headquarters and doctor's offices; marked by concrete block 2 by 2 by 3 feet (61 by 61 by 91 cm.), set but slightly in the ground.

Jenjere, 1914.—About 600 feet (183 meters) north of temporary depot, in edge of bush, west of compound of Tin Mine Companies, and southwest of small market place; marked by tent-peg. True bearing: date palm near small market, 207° 41′.5.

Jimeta, 1914.—On west side of Benue River, 300 yards (274 meters) south of Nigeria Company wharf and warehouse, and southeast of compound and canteen, 53.9 feet (16.43 meters) east of east corner of mud fence around rest-house, and 33 feet (10.1 meters) west of edge of rocky slope leading down to flood plain of river; marked by tent-peg. Arrangement was made to have station marked with cement pier. True bearing: danger signal in rocks near wharf, 178° 40′.7.

Kaduna, 1914.—On ground being built up with general offices of railroad, about 300 yards (274 meters) southeast of railroad station, 93 feet (28.3 meters) south of rest-house, 21 feet (6.4 meters) northeast of center of street, and west of tennis-court.

Kano, 1914.—Northwest of rest-house, in cluster of boulders, 9.7 feet (2.96 meters) west and 7.3 feet (2.22 meters) north of small boulders, and 19.8 feet (6.03 meters) east-southeast of north end of a boulder 35 feet (10.7 meters) long, 15 feet (4.6 meters) wide, and 5 feet (1.5 meters) high, lying with greatest length northwest and southeast; a large boulder 30 feet (9.1 meters) high and entirely above ground, is about 70 yards (64 meters) south.

Kwagal, Central Province, 1914.—On plain north of rest-house buildings, 150 feet (46 meters) northwest of large main rest-house; marked by tent-peg. True bearing: papaw tree in village, 132° 05′.2.

Lagos, 1914, 1915.—Three stations, designated *A*, *B*, and *C*, were occupied. Station *A* is reoccupation of C. I. W. station of 1913, over a pier about 1 meter high, marked 220P.IKP, 20 chains (402 meters) north of Lagos Observatory and about 2 miles (3 km.) from Jones Hotel. True bearing: plumb-line over line-marker, 180° 00′.2. It was found that cross marking station is in top of an iron bar 1 inch (2.5 cm.) in diameter and not less than 12 inches (30 cm.) long.

Station *B* is over pier 265P, north end of meridian line of Southern Nigerian Survey, south end being pier described as station *A*; top is 8 inches (20 cm.) below surface of ground, and precise point is indicated by head of an iron nail imbedded in concrete. True bearing: pier 220P.IKP, described as station *A*, 330 feet (100.6 meters), 0° 00′.2.

Station *C* is about 200 meters east of cemeteries, 31.9 meters north of center of metaled road, exactly in line with centers of two cement piers standing about 60 meters apart and having iron pins at their centers, 27.50 meters northeast of smaller and more easterly pier which is marked 651, PB; marked by stake with two water bottles buried beside it. True bearing: line through centers of two cement piers, 79° 21′.9.

Lau, Muri, 1914.—East of village on south bank of small creek flowing almost directly west into Benue River, on high level ground between short ravine about 20 feet (6 meters) deep and 75 yards (69 meters) long and slope leading down from village to ford and watering-place, 20 feet (6.1 meters) south of edge of bank of creek.

Loko, Nassarawa, 1914.—In old peanut fields west of village and about 900 feet (274 meters) north of Benue River, 106 feet (32.3 meters) west of southwest corner of grounds of district resident, 25 feet (7.6 meters) northeast of high termite or white-ant hill, and 70 feet (21.3 meters) north of nearest of three young trees in line with station and 15 feet (4.6 meters) apart; marked by a tent-peg. True bearings: steel flagpole in front of resident's house, 261° 38′.4; west gable of post-and-telegraph office, 304° 58′.2.

Lokoja, Kabba, 1914.—Part-way up on southern end of flat-top hill just west of town and north of rifle range, reached by path turning to right from road leading from town past prison just above ridge connecting small knoll northeast of target pit and backstop with larger hill to north, 12 feet (3.7 meters) north of a tree 10 inches (25 cm.) in diameter; marked by a tent-peg. True bearings: steel flagpole on hill at back of targets, 71° 35′.0; flagpole in front of house of cantonment magistrate, 279° 10′.6.

Onitsha, Central Province, 1914.—Northeast of Niger River, north of town, on ridge occupied by government buildings, at edge of path from west side of hospital building going northward down hill and curving gradually to right towards arched concrete bridge over small creek, at a point 350 feet (106.7 meters) south of large tree standing in center of path; marked by a tent-peg. True bearings: lone palm tree on eastern horizon, 287° 05′.3; flagpole near doctor's house, 338° 46′.1.

Oshogbo, 1914.—On government land on west side of main road leading to depot and post-office, about half mile (0.8 km.) south of railroad station, 18.6 feet (5.67 meters) north of center of gravel path leading west from main road to government and railroad bungalows, 23.8 feet (7.25 meters) northwest from center of path at junction with branch path leading southward to rest-house, and 114 feet (34.7 meters) north of northeast corner of rest-house; marked by triangular slab of concrete set flush with ground.

Serikin Pawa, 1914.—In field of guinea corn, about 500 yards (457 meters) west of railroad, measured from point about 200 feet (61 meters) south of south switch.

Shillem, Yola Province, 1914.—Inside old mud wall of town on side nearest river, on inside slope of ruins of old wall, 130 feet (39.6 meters) west-southwest of southwest side of south room of rest-house, and 75 feet (22.9 meters) southwest of large tree near old wall; marked by a wooden stake. True bearing: tree on southern horizon, 329° 54′.5.

Yale, Bornu, 1919.—In scrub east of village, 23 paces east of low mud wall bounding village on east, and 39 paces northeast of gap in wall through which runs main street leading east from sultan's compound.

AFRICA.

NIGERIA—*concluded.*

Zaria, 1914.—About 300 feet (91 meters) west of railroad right-of-way fence, near one of the holes of golf links, and about due west of point midway between railroad rest-house and residence of foreman of works; marked by tent-peg. True bearings: boulder on top of long hill, 10° 06'.0; south edge of provincial commissioner's house, 136° 54'.4; pinnacle on west gable of depot, 254° 21'.3.

Zungeru, 1914.—On rifle range northwest of railroad station, 12 feet (3.7 meters) north of point in line with north edge of 600-yard firing platform and 10.5 feet (3.20 meters) east of its northeast corner; marked by stone projecting 3 inches (8 cm.) above ground. True bearing: flagpole beyond barracks, 152° 11'.5.

PORTUGUESE EAST AFRICA.

Ankuaze, 1920.—On left bank of Zambezi River, on property of "Sociedade Agricola do Guengue," on barren spot in cotton field about 100 meters southeast of residence, and 14 paces east of center of path through field; marked by hardwood post 1 meter high. True bearings: large shady tree on river bank, 51° 34.'7; left edge of south pillar of residence, 117° 24'.5; lone tree west of path, 22 paces, 124° 03'.

Bandar, 1920.—On left bank of Zambezi River, at southeast end of Lupata Gorge, about 200 meters northwest of old trading post, east of wood station for steamers, 5 paces west of Kafir track leading up steep hill and 39 paces northeast of east palm tree of two on river bank. True bearings: east palm tree on river bank, 43° 29'.3; large baobab tree on opposite bank of river, 0.7 kilometer, 47° 47'.4; near gable of sheet-iron building at trading post, 301° 04'.8.

Beira, 1920.—Four stations were occupied. Station *A* is a practical reoccupation of Dr. J. C. Beattie's station of 1906, on low grass-land about 0.5 kilometer northeast of railway station, in line with south side of large locomotive shed produced southeastward about 350 meters, 162 paces southeast of native workers' canteen, and 40 paces south of point where path crosses swamp channel. True bearings: central stack of three at power station, 1.5 kilometers, 24° 31'.4; near corner of native canteen, 113° 13'.0; south end of roof of locomotive shed, 122° 47'.7; east gable of large distant store building, 1 kilometer, 201° 41'.1.

Two secondary stations, *N* and *S*, were occupied for testing for local disturbance; *S* is 80 paces south of station *A* on line to stack at power station; *N* is 120 paces north of *A* on same line.

Station *B* is about 1 kilometer south of station *A*, about 0.5 kilometer northeast of governor's palace, near northeast boundary of sports ground, 13.3 meters from northwest goal post, and 15.7 meters from northeast goal-post of foot-ball field, and exactly in line with northwest and southwest goal-posts. True bearings: stack of electric power-station, 1 kilometer, 70° 57'.2; wind-vane on tower of observatory, 1 kilometer, 346° 38'.9; cross on church steeple, 1 kilometer, 356° 01'.2.

See also *Macute Point*.

Boroma, 1920.—On right bank of Zambezi River, on property of Jesuit Mission, about 200 meters west of pumping station, on open flat 40 paces from southern base of steep hill on which Mission buildings are located, in angle formed by two foot-paths just west of grove, 101 paces southwest of south corner of old foundation at end of road to Mission; marked by brick pillar, faced with cement. True bearings: prominent tree on ridge, 2 kilometers, 35° 18'.8; southwest corner of pumping station, 260° 33'.3.

AFRICA.

PORTUGUESE EAST AFRICA—*continued.*

Cachomba, 1920.—On open land near southeast corner of Portuguese military fort, 29.05 meters southwest of junction of tambour and south wall, and 24.85 meters south of south wall of fort. True bearings: flagstaff in southwest corner of fort, about 85 meters, 99° 59'.6; outer edge of west side of south gateway, 42.70 meters, 118° 36'.2; flagstaff on southeast tambour, 212° 52'.8; flagstaff on baobab tree at rifle range, 1 kilometer, 356° 29'.4.

Captiva, 1920.—On grassy flat, below rocky sandstone slope on which is built rest-camp for travelers, east of native village, in line with veranda posts along southeast side of house for white men, and 6 paces northwest of path across grassy flat. True bearings: southeast corner-post of house for white men, 27 paces, 57° 41'.8; top of conical mountain, 30 kilometers, 195° 21'.1; tree at end of sandstone range, 5 kilometers, 296° 37'.9; cross mark on large tree, 35 paces, 328° 09'.2.

Chemba, 1920.—On right bank of Zambezi River, on Mozambique Company's cotton ginnery reserve, 66.10 meters south of south corner of wall around manager's residence, east of servants' quarters, and about 150 meters southeast of cotton ginnery; marked by cement-faced brick pillar, 1 meter high, inscribed "C. I. W. 1920." True bearings: prominent tree on distant ridge, 4 kilometers, 15° 23'.2; left gable of store building behind ginnery, 102° 32'.8; chimney stack of ginnery, 110° 10'.8; south gable of residence, about 100 meters, 181° 22'.0.

Chicoa, 1920.—On open ground south of post of Zambezi Company, and exactly in line with southeast fence of compound, and 5.85 meters from nearest banana palm. True bearings: top of cliff at Zambezi gorge, 25 kilometers, 81° 39'.5; flagstaff of post, 28.45 meters, 142° 03'.3; southeast veranda post of residence of agent, 179° 42'.0; southeast corner of compound, 27.50 meters, 215° 11'.0; near gable of east one of two houses for travelers, about 100 meters, 331° 22'.1.

Chinde, 1920.—Close reoccupation of C. I. W. station of 1909. In space used as garden within "Extra Concession," 25 paces southwest of road which leads past British Concession to golf shelter at beach, opposite point in road 346 paces southeast from high fence of British Concession. True bearings: south veranda post of red-roofed bungalow, 1 kilometer, 15° 37'.0; east edge of British consulate, about 400 meters, 145° 03'.9; flagstaff at Portuguese government office, 400 meters, 201° 28'.8.

Chindio, 1920.—On grazing land about 0.5 kilometer east-southeast of railway station, 9 paces north of Kafir trail, in line of buffers at east end of railway siding produced 212 paces southward, and in line with north end of large goods-shed west of railway. True bearings: northeast corner of brick house, 105 paces, 27° 10'.2; north end roof of large railway goods-shed, 65° 36'.2; top of railway tank at southwest corner, 84° 04'.4; north spike on railway station, 101° 44'.3; buffers at end of railway siding, 157° 19'.8.

Macute Point, 1920.—An attempt to reoccupy British Admiralty observing point of 1892, about 2 miles (3 kilometers) east of town, near coast, on crest of broken line of sand dunes, about 150 meters southwest of cable-house of Eastern and South African Company, where cable is landed and carried overland to Beira, 110 paces south of third pole of overhead cable line. True bearings: southmost visible telegraph pole on coast, 2 kilometers, 91° 01'.6; bottom of pole at cable-house, 235° 58'.7; top of lighthouse tower, 1 kilometer, 242° 49'.9.

See also *Beira*,

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PORTUGUESE EAST AFRICA—*continued.*

Mashambo, 1920.—On open space in front of Zambezi Company's rest-house for travelers, in line of west side of front rest-house, approximately in line between southeast corner of lion-proof palisade and large baobab tree, 27.85 meters east of south corner of natives' compound, and 17.05 meters northeast of center of baobab tree. True bearings: east corner of natives' compound, 119° 20′.0; southwest veranda post of rest-house, 18.90 meters, 186° 04′.2; southeast corner of rest-house compound, about 30 meters, 226° 27′.6.

Mopea, 1920.—Possibly 5 miles (8 km.) northwest of C. I. W. station *Mapia*, 1909, which could not be recovered. On premises of factory of Sena Sugar Estates Ltd., about 5 kilometers north of river landing, on unused land southeast of hospital, about 400 meters southeast of manager's residence, in line of fence inclosing tree nursery 100 paces southeast of south corner, 142 paces north of factory-railway; marked by cement-faced brick pillar, 1 meter high, inscribed on top C. I. W. True bearings: south tower on roof of manager's residence, 111° 43′.4; turret on club-house, about 500 meters, 115° 05′.7; south end of roof of hospital, about 200 meters, 163° 28′.7; north end of roof of repair shop, 330° 27′.9.

Mozambique, 1920.—Two stations were occupied. Station *A* is 12 meters north of C. I. W. station of 1909, in line with southwest goal-posts of football field, 49 paces southeast of nearer post, 201 paces southwest of southwest corner of Fort St. Sebastien, 180 paces from house in west part of Campo Gabriel. True bearings: cross on church on beach, 2 kilometers, 36° 17′.9; flagstaff at south corner of Fort St. Sebastien, 300 meters, 241° 22′.6; top of lighthouse tower, 5 kilometers, 296° 55′.8.

Station *B* is close reoccupation of F. A. Chaves' station of 1906, about 100 meters northeast of station *A*, in middle of rifle range, south of southwest wing of Fort St. Sebastien, 87 paces southeast of middle stone pillar of three at northwest end of range. True bearings: cross of church on beach, 2 kilometers, 37° 37′.8; middle pillar at end of rifle range, 138° 00′.1; flagstaff on south corner of fort, 243° 53′.8; top of lighthouse tower, 5 kilometers, 298° 00′.7.

Panhame, 1920.—On right bank of Zambezi River, about 24 kilometers below Zumbo, on waste land about 50 meters northeast of residence of agent of Zambezi Company, and 19.55 meters northeast of northeast corner of raised foundation of house destroyed in 1917 rebellion; marked by cartridge-case hammered flush with ground, to be replaced by a stone column 30 centimeters square and 1 meter high. True bearings: north end of native sepoy's guard-room, about 70 meters, 15° 50′.5; northeast corner of foundation of former house, 67° 14′.3; distant conical peak, 188° 34′.0; distant prominent tree, 1 kilometer, 275° 50′.6.

Porto Amelia, 1920.—At west end of open sandy space which extends along hill-top between government offices and military headquarters, 190 paces west of west corner of platform of governor's residence, exactly in line of fence along southeast side of fenced inclosure, and 48 paces southwest of stone at south corner. True bearings: flagstaff at office in town, 0.5 kilometers, 84° 35′.4; top of isolated peak in interior, 30 kilometers, 106° 31′.9; west end of roof of governor's residence, 291° 24′.1; flagstaff at military headquarters, 329° 25′.0; northwest corner of wall around military headquarters, 341° 18′.1.

Tete, 1920.—At northeast end of open ground between post-office and governor's palace, in line of northwest side of compound northeast of governor's palace, 43.85 meters northeast of its north corner, and 11.18 meters southeast of southeast corner of base of sun-dial erected by Dr. Livingstone; marked by cement-covered brick pillar, 1 meter high, inscribed on top C. I. W. 1920. True bearings: east gable of red-roofed residence on hill, 0.6 kilometer, 75° 28′.6; left end roof of small building of paper factory across river, 1 kilometer, 225° 34′.5; near corner of post-office, about 50 meters, 244° 51′.7; top of church steeple, about 200 meters, 295° 55′.4; south end roof of British consular agency, 323° 57′.0.

AFRICA.

PORTUGUESE EAST AFRICA—*concluded.*

Tete, 1920—continued.

SOUTHWEST AFRICA.

Aus, 1916.—Close reoccupation of station of 1909, to right of railway to Seeheim, south of town, on small area from which surface stones have all been removed, 260 paces south of south face of galvanized iron house occupied by railway inspector, formerly doctor's house of old hospital, and 12 paces east of Kubub road; marked by somewhat pointed white quartz stone, upper face of which is about 8 by 3.5 inches (20 by 9 cm.), left 7 inches (18 cm.) above surface. True bearings: perpendicular north edge of hill, 43° 35′.4; pinnacle on west gable of railroad inspector's house, 114° 41′.6; finial over east end of police station, 168° 37′.7; center of stone beacon, 337° 36′.4.

Gibeon, 1916.—Close reoccupation of station of 1909, immediately north of village and above small stream tributary to Fish River, on middle summit of hill with triple crown, the most easterly summit of which is occupied by native Location, and westerly by stone beacon, on ground covered with hard blackish stones of all sizes weighing up to 150 pounds. True bearings: ornament over west door of public building, 4° 33′.7; beacon on skyline, 10° 46′.0; steeple of church, 36° 47′.5; approximate center of beacon on west crown, 91° 19′.7; easterly one of two steel telegraph-poles, 198° 07′.3; southernmost steel telegraph-pole above skyline, 311° 25′.2.

Keetmanshoop, 1916.—Close reoccupation of station of 1909, in general vicinity of race-track and football ground, 400 paces north of point on railway which is 400 paces east of east face of stone railroad station; marked by tent-peg. True bearings: finial over east end of large house, 16° 03′.9; lightning rod on tower of railroad station, 61° 48′.6; highest point on south one of two small peaks about 1 mile (1.6 km.) 90° 27′.3; west peak of distant twin peaks about 6 miles (10 km.), 345° 47′.9.

Seeheim, 1916.—Proximate reoccupation of station of 1909, which could not be located owing to changes in railroad and bridges, on left bank of Fish River, 202 paces north of railroad from a point 165 paces east of east end of the one of two steel truss bridges over Fish River nearest Seeheim, and 165 paces south-southwest of nearest corner of plot of ground containing two graves and surrounded by masonry wall 2 feet (0.6 meter) high, surmounted by four iron pipes supporting a single chain; marked by tent-stake. True bearings: approximate center of beacon across Fish River, 74° 22′.0; steeple of old hotel on hill, 298° 26′.9; steel telegraph-pole, 309° 22′.0.

Swakopmund, 1916.—Close reoccupation of station of 1909, southwest of distillery, just east of east line of Moltke Street, and exactly in line joining old Hohenzollern Hotel, now a private house, and second window of back shed of pumping-station, about 200 yards (183 meters) southeast of railroad to Walfish Bay, and

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SOUTHWEST AFRICA—*concluded.*

Swakopmund, 1916—continued.
about 250 yards (229 meters) north of pump-house; marked by tent peg driven flush with sand. True bearings: point on nearest chimney on roof of wireless office, 70° 42′.5; top point on square cupola of Behnke's Brennerei (malt-house), 133° 30′.8; flagpole of barracks, 153° 05′.2; flagpole of Damara House tower, 163° 31′.3; weather-vane on lighthouse, 167° 03′.5; west front of old Hohenzollern Hotel, 171° 41′.4; clock tower of German Protestant church, 198° 21′.4; finial over bay window of pump-house, 346° 14′.4.

Windhoek, 1916.—About 10 meters west of station of 1909, within laid-out street marked by rows of stones, leading southward from Elizabethheim, on ridge west of town, 117.2 meters southeast of an iron stake marking property corner on west edge of street, 12.4 meters east of west edge of street and 8 meters west of east edge; marked by rectangular milky-white quartz stone, 9 inches (23 cm.) long, left 2 inches (5 cm.) below surface of ground. True bearings: most northwesterly wireless tower, 34° 54′.5; projection on distant hill, 62° 23′.9; finial over west end of building beyond railroad station, 225° 58′.0; tower of castle-like house, 247° 11′.5; steeple of governor's house, 281° 01′.1; church steeple, 290° 56′.1; steeple of public building, 325° 27′.9; tower of Elizabethheim, 338° 00′.7; west edge of west pillar of north veranda, 338° 38′.7.

SPANISH GUINEA.

Bata, 1915.—In open grass plot about 120 meters southeast of customs warehouse, about 25 meters south of intersection of street parallel to beach with street extending from harbor to post-office, and about 40 meters south of large mangrove tree which stands north of street intersection. True bearings: center gable window of customs office, 125° 33′.2; harbor light, 216° 42′.7; flagpole at post-office, 284° 01′.5.

Elobey, 1915.—Near western side of smaller of two Elobey Islands, across street southwest of office of general secretary, 23.96 meters from lamp-post in front of office, 16.25 meters from center of street, and 10.50 meters southeast of lone oil-palm tree. True bearings: northeast end of Corisco Island, 72° 20′.9; lamp-post before secretary's office, 204° 35′.

Rio Campo, 1919.—On left bank of River Campo, opposite French post of Campo in Cameroun, on cleared land south of path leading from canoe shed on river bank to Spanish military post, 9.6 meters south of path measured at right angles from a point which is 155.75 meters east of middle pillar of east side of Spanish lieutenant's house and 42 paces west of west end of canoe shed, measured along path; marked by cement block 0.2 by 0.2 by 0.55 meter, its top face left about 0.15 meter above surface of ground, a small cross-cut indicating exact instrument center. True bearings: near gable end of Spanish lieutenant's house, 93° 07′.9; near gable end of office, about 130 meters, 101° 34′.6; south gable end of lieutenant's house in French Campo, half mile (0.8 km.), 189° 31′.2; bottom of flagstaff at French military post, one-third mile (0.5 km.), 191° 37′.6; bottom of left corner of iron sheet on tree for harbor mark, 1.5 miles (2.4 km.), 218° 39′.8; near end of ridge-pole of canoe shed, 42 paces, 252° 08′.0.

TRIPOLITANIA.

Misurata, 1914.—North of town, on hill at east end of line of hills, about 125 meters east of fort, and 81 meters east of southeast corner of barbed-wire barricade surrounding fort; marked by 2.5-centimeter drill-hole in top of rough limestone post 35 by 20 by 15 centimeters, set flush with ground. True bearings: flagstaff on fort, 82° 51′.5; foot of eastern wireless mast, 335° 07′.5; foot of western wireless mast, 342° 23′.5.

Syrte, 1914.—On a sandhill about 0.5 kilometer southwest of Residenza, 30 meters south-southeast from telegraph line, and 30 meters northwest from small graveyard of two Italian soldiers; marked by rough sandstone post about 65 centimeters long and 15 by 15 centimeters at top, set flush with ground. True bearings: northwest corner of Residenza, 242° 07′.4; foot of flagstaff on Residenza, 246° 20′.4.

Tripoli, 1914.—Exact reoccupation of station of 1913, at Dahra, suburb just east of Tripoli, in grove of palm trees south of elementary school conducted by Catholic Sisters, 27.5 meters from southeast corner of low stone building, 50.1 meters from stone wall on west, and 41.0 meters from stone wall on east. True bearings: tip of pyramidal chimney cover, 55° 30′.9; minaret of Mosque Hamid Pasha Karamanli, 100° 30′.5.

UGANDA.

Gondokoro, Nile, 1918.—Close reoccupation of station of 1909, on edge of high right bank of Nile, southwest of Catholic Mission, about 120 meters southwest of remaining government building, and about 250 meters south of Nile gage. True bearing: west one of two straight small trees, 354° 52′.1.

Rejaf, Lado, 1918.—West of town, north of Jebel Rejaf, just north of northeast corner of compound of residence of mechanical transport officer, about 200 meters northwest of road passing in front of inspector's residence, and on eastern edge of ledge of rocks exposed by small water-course, at a point about 50 meters south of its junction with another branch; marked by tent-peg. True bearings: northwest edge of large rock high up on Jebel Rejaf, 10° 52′.1; steel telegraph pole near rest-house compound, 256° 36′.3.

ASIA.

ARABIA.

Aden, 1914, 1918.—Stations of 1914 and 1918 are identical and about 40 meters west-northwest of stations of 1909 and 1911. About 50 meters west-northwest of Victoria Monument, 35.7 meters north of well in front of Hôtel de l'Europe, and 33.9 meters and 35.6 meters southwest respectively of west and east ends of culvert under roadway; marked by tent peg driven flush with ground. True bearings: center of ball on clock tower, 103° 42′.8; flagpole of custom-house, 132° 12′.6; flagpole on Quarantine Island, 196° 45′.6; flagpole of signal station mountain top, 296° 45′.1.

Jidda, 1918.—Close reoccupation of station of 1911, southwest of Jidda, on low sandy reef called "Jezirat el Mifsaka" on British Admiralty charts, just east of anchorage, on highest part marking limit of high tide; marked by a large wooden stake. True bearings: mosque in northwest part of Jidda, 209° 23′.1; tall minaret on mosque in western part, 212° 36′.8; mosque, 217° 55′.2; mosque 219° 31′.4; tall minaret on mosque at southeastern corner of city wall, 226° 31′.6.

CHINA.

Achikai, Yunnan, 1917.—On lower slope of hill north of village about 400 feet (122 meters) along main road from north gate, on small piece of open land situated just inside junction of main road with a footpath

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CHINA—*continued.*

Achikai, Yunnan, 1917—continued. leading up hill, about 80 feet (24 meters) north of junction, 6 paces west of footpath, 5 paces east of top of bank overlooking main road, 42 paces from grave to north. True bearings: left end of roof of temple, one-third mile (0.5 km.), 11° 53′.6; top westmost support of north gate of village, 16° 10′.5.

Amoy, Fukien, 1917.—Exact reoccupation of station of 1906. In south corner of lawn of residence of British consul, in foreign concession on Kulangsen Island, near top of short flight of steps leading down hillside from flagstaff, 109 feet (33.2 meters) south of south corner of consul's residence, 15.2 feet (4.63 meters) from tree to southeast near steps, 9.5 feet (2.9 meters) west of square concrete pillar near head of steps; marked by granite cylinder 18 inches (46 cm.) in diameter projecting 8 inches (20 cm.) above ground upon top of which a brass plate has been fastened giving latitude and longitude as previously determined. True bearings: top of pagoda on mountain, 5 miles (8 km.), 3° 59′.6; west corner of consul's residence, 152° 35′.0; east corner of consul's residence, 195° 14′.2; bottom of right side of flagstaff, 238° 00′.6.

Anda Station, Heilungkiang, Manchuria, 1916.—In north corner of waste land lying between railway line and southwest edge of Chinese town, exactly in line with northwest side of westmost street of town, about 400 feet (122 meters) northeast of large compound containing Russian residences, 245 feet (74.7 meters) southwest of tall light-standard, 363 feet (110.6 meters) southwest of south corner of Chinese house at end of westmost street in town, 23 paces southwest of edge of cart track. True bearings: top of railway water-tower, 6° 32′.9; bottom of cross on small house in northeast corner of Russian compound, 56° 08′.1; bottom of signal arm on railway, 103° 58′.9; southeast corner of house at end of street, 363 feet (110.6 meters), 223° 29′.0; center of winding apparatus at bottom of light-standard, 245 feet (74.7 meters), 232° 56′.7; near gable end of iron-roofed house, about 400 feet (122 meters), 253° 57′.3; top of eastmost water-tower, two-thirds mile (1 km.), 333° 17′.2; spike on front gable of railway station, 354° 13′.5.

Anlu, Hupeh, 1916.—On left bank of Han River, about half mile (0.8 km.) below usual boat mooring, at edge of cultivated area between river and grass-covered dike beyond first series of cultivated fields, about one-third way from river to dike. True bearing: tip of low tower in group of temple buildings on hill near corner of city wall, about 1.5 miles (2.4 km.), 272° 28′.7.

Antung, Shengking, Manchuria, 1916.—On hillside on west boundary of Chinese new park (known as Yuan Pao Shan), which is situated on south slopes of high wooded hills rising north of Chinese city, about midway between edge of woodland and grave land, about 350 feet (107 meters) north of tea pavilion; marked by granite block, 8 by 8 by 36 inches (20 by 20 by 91 cm.), left just above surface of ground and lettered C. I. W. 1916 on top face, a small drill hole marking exact instrument center. True bearings: center of red-roofed tower over white house, 1.5 miles (2.4 km.), 0° 46′.2; near gable end of leftmost large godown of railway, 2 miles (3 km.), 2° 41′.1; right edge of house on opposite hill, one-third mile (0.5 km.), 21° 56′.5; center of ornament on work-house, one-fourth mile (0.4 km.), 73° 20′.2; ornament on roof of pavilion on opposite hill, one-fourth mile (0.4 km.), 281° 21′.4; top of tower of Yokohama Specie Bank building, 1 mile (1.6 km.), 358° 16′.8.

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CHINA—*continued.*

Arra Hottock, Outer Mongolia, 1915.—About 12 miles (19.3 km.) west and 20 miles (32 km.) south of ford where road from Urga to Barron Kurin crosses Tola Gol, about 11 paces southeast of road, at top of plateau where it dips into valley of small stream which, after flowing northward from Arra Hottock (well), turns to eastward, about one fourth-mile (0.4 km.) north of Arra Hottock.

Booralchin Temple, Outer Mongolia, 1915.—On plain about 900 feet (274 meters) northwest of Booralchin Temple, which lies about one-third mile (0.5 km.) east of main ox-cart road from Kalgan to Urga, roughly in line with southwest side of westmost of temple buildings. True bearings: leftmost of four peaks in range to northwest, 10 miles (16 km.), 100° 49′.5; center ornament on roof of temple, 328° 40′.6; right gable end of rightmost temple building, 330° 25′.1.

Boskhun Bollock, Outer Mongolia, 1915.—Near site of eleventh camp on main courier road from Urga to Uliassutai, beside large spring called Boskhun Bollock or "Raised-up Spring," about 100 feet (30 meters) southeast of spring and about 10 paces northeast of edge of stream. True bearings: horse pole at courier station, 300 meters, 191° 30′.1; bottom of leftmost pole of horse lines, 214° 26′.1; top of conical mountain, 10 miles (16 km.), 231° 24′.4.

Buchedu, Heilungkiang, Manchuria, 1916.—In Russian public park, about half mile (0.8 km.) north of railway station, on hillside just below west end of Russian cemetery and just north of inclosed garden on bluff overlooking town, situated on north half of grass-land inclosed by horseshoe-shaped avenue planted with small trees, 298.5 feet (90.98 meters) south of southwest corner of cemetery fence, 180.5 feet (55.02 meters) north of eastmost post of inclosure around garden on bluff, 104.5 feet (31.85 meters) from nearest tree to north, 45.5 feet (13.87 meters) from nearest tree to west, and 44 feet (13.4 meters) from nearest tree to east; marked by wooden peg with small cross cut in top face, set just below ground. True bearings: bottom of leftmost post of garden inclosure, 2° 53′.8; top of railway water-tower, half mile (0.8 km), 68° 57′.6; near gable end of near train shed, half mile (0.8 km.), 84° 21′.0; near gable end of solitary red house on plain, 1.5 miles (2.4 km.), 101° 51′.7; cross on church tower, half mile (0.8 km.), 122° 03′.2; top of near corner of cemetery fence, 298.5 feet (90.98 meters), 176° 03′.2.

Canton, A_s and B_s, Kwangtung, 1914, 1915, 1917.—In June 1914, two non-magnetic observing huts, designated *A* and *B*, were erected near southeast corner of campus of Canton Christian College, on parkway about 165 feet (50 meters) south of Residence 20 or Jackson Lodge, hut *A* being 89 feet (27.1 meters) 11½° south of east from hut *B*. Each hut contains two piers, 3.5 feet (1.07 meters) apart, in approximate magnetic meridian, north piers being designated A_n and B_n, and south piers, A_s and B_s respectively. These piers consist of solid hardwood posts, 8 inches (20 cm.) in diameter, set firmly in earth and embedded in cement concrete, and have brass plates with footscrew grooves attached to their tops. Magnetic observations are made chiefly on piers A_s and B_s, and for these, true bearings have been adopted as follows: From A_s: cross on wall at east end of Residence 20, 190° 00′.4; top of Whampoa Pagoda, 267° 28′.2. From B_s: cross on pillar near west end of Residence 20, 192° 42′.6; top of Whampoa Pagoda, 261° 31′.5.

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CHINA—*continued*.

Canton 3, Kwangtung, 1915.—Close reoccupation of station of 1908 and 1911, on grounds of Canton Christian College at Honglok, Honan Island, about 3 miles east of Canton on south side of Pearl River, near south boundary of level rectangular tract east of main campus, on summit of a grave hill called "Sixty-Foot Hill" about one-third mile (0.5 km.) north of observing huts *A* and *B*. True bearings: top of Flowery Pagoda, 128° 58′.4; tip of western cupola of Dormitory No. 73, 69° 55′.7.

Chahgar Tzu Tien, Kweisuitao, 1916.—On sandy land north of inn on lower road from Patsebolong to Paotowchen, two days' journey from each place, 140 feet (42.7 meters) north 36° 57′ west of north corner of inn wall, 156 feet (47.5 meters) north of west corner of inn wall. True bearings: center ornament on large temple, 2 miles (3 km.), 99° 55′.4; bottom of large pole on left side Mongol Camp, 1 mile (1.6 km.), 199° 55′.1; right edge of rightmost chimney of inn, 358° 02′.7.

Changshan Che, Chekiang, 1917.—In northwest corner of cemetery of China Inland Mission, a level tract about half mile (0.8 km.) southwest of south gate of city, among some low hills known as "Si Yang Shan," on piece of grass-land between cultivated land at west end of cemetery and foot of low grave-hill rising to north 18.5 feet (5.64 meters) west of front face of Mrs. Wu's tomb, and 58 feet (17.7 meters) southeast of solitary tallow tree in northwest corner of cemetery. True bearings: bottom of lone tallow tree, 124° 20′; bottom of right edge of wayside shrine, half mile (0.8 km.), 170° 05′.7; left gable end of rear building of white compound for storing coffins, half mile (0.8 km.), 175° 47′.3; top of front of Mrs. Wu's grave, 261° 44′.1; near gable end of small shrine, about 250 feet (76 meters), 332° 44′.1.

Changteh, Hunan, 1915.—In grounds of American Presbyterian Mission, in Girls' School compound, 165.5 feet (50.44 meters) northwest of northwest corner of school building, 151 feet (46 meters) southeast of northwest corner of compound, and about 260 feet (79 meters) north of entrance; marked by a stone 6 by 6 by 26 inches (15 by 15 by 66 cm.) set flush with surface of ground and having the letters C. I. W. 1915 cut in top and a hole at center to mark precise point. True bearings: bottom of left edge of entrance, 13° 28′.1; top of right edge of church, one-fourth mile (0.4 km.), 20° 17′.5; top of right edge of missionaries' house, one-fourth mile (0.4 km.), 22° 54′.5; northwest corner of compound wall, 148° 47′.7; northwest corner of girls' school building, 285° 26′.0; bottom of southwest corner of girls' school building, 210 feet (64 meters), 311° 42′.0.

Chaotung Yun, Yunnan, 1916.—On grave-land just east of southeast corner of school compound of Methodist Mission which is situated about half mile (0.8 km.) northeast of east gate of city, 137 feet (41.8 meters) east of southeast boundary stone of school compound, 119 feet (36.3 meters) southeast of eastmost of two boundary stones at back gate of compound, 178.5 feet (54.41 meters) south of northeast corner of compound wall, 5 paces west of edge of old moat, 4 paces southwest of old grave, 8 paces southeast of edge of path. True bearings: left end of left roof ornament on east gate of city, half mile (0.8 km.), 63° 35′.7; southeast corner of school-compound wall, 89° 27′.3; top of ornament on tower in city, one-third mile (0.5 km.), 100° 38′.4; right gable end of mission residence, 250 feet (76.2 meters), 138° 40′.0; northeast corner of school-compound wall, 172° 08′.6; leftmost of two monumental grave pillars on hill, 1 mile (1.6 km.), 329° 45′.2.

Chenchow, Hunan, 1915.—Near east end of compound of girls' school of American Presbyterian Mission, near west gate of city, 69 feet (21.0 meters) west of east wall of compound, and in line with south wall of girls' school; marked by hardwood peg driven flush with ground. True bearings: southeast corner of girls' school, 110 feet 9 inches (33.76 meters), 102° 33′.7; northeast corner of girls' school, 130 feet (39.6 meters), 130° 23′.6; top of northernmost cross on chapel, 450 feet (137 meters), 139° 46′.1; northeast corner of compound wall, 109 feet (33.2 meters), 234° 03′.3; near gable end of farm house on hillside, three-fourths mile (1.2 km.), 254° 28′.5; top of ornament on pagoda, half mile (0.8 km.), 343° 09′.9.

Chenfanhsien, Kansu, 1916.—Near northeast corner of city on a piece of waste land between swamp and east city wall, 41 paces from bottom of slope of east city wall, and 319 feet (97.2 meters) from south corner of temple in northeast corner of city wall. True bearings: center of top ornament on top of temple, 2° 29′.8; north gable end of nearest yamen building, 30° 30′.1; tip of pagoda tower, 61° 21′.5; near gable end of north gate fort, one-fifth mile (0.3 km.), 108° 34′.4; tip of center ornament of temple near northeast corner of wall, 194° 01′.9; right gable end of fort in northeast corner of wall, 360 feet (110 meters), 201° 58′.8.

Chengchang, Kansu, 1916.—About 30 meters southwest of station of 1909, inside ruined wall of former village, near southeast corner, behind first inn on left as village is entered from southeast, 72 feet (21.9 meters) southwest of west corner of inn yard, and 311 feet (94.8 meters) east of east corner of temple in west corner of wall. True bearings: center ornament on roof of temple, 85° 54′.0; ornament over entrance to temple, 91° 14′.2; top of small conical peak, 10 miles (16 km.), 235° 32′.3.

Chengsokwan, Shensi, 1915.—On road to Tungkwan, 20 miles (32 km.) from Yichüan, near middle of uncultivated plot surrounded by low stone wall, between village and stream, about midway of village, 7 feet (2.1 meters), and 33 feet (10.1 meters) from east and north walls of plot respectively. True bearing: eastern side of granite cylinder on threshing floor, about 250 yards (229 meters), 349° 54′.6.

Chengtehfu (Jehol), Chihli, 1915.—On hillside north of city and south of western part of palace grounds, at elevation of about 100 feet (30 meters) above main street in northeast corner of English Mission hospital compound, 33.2 feet (10.12 meters) west of east wall and 37.8 feet (11.52 meters south of north wall; marked by conical hole cut in approximate center of top face of building stone 3 by 12 inches (8 by 30 cm.) in horizontal section, left projecting 3 inches (8 cm.) above ground. True bearings: vertical axis of top ornament on small kiosk on hill in palace grounds, about one-fourth mile (0.4 km.), 158° 18′.4; shoulder on prominent distant mountain, 347° 07′.7.

Chengtu, Szechwan, 1916.—On grounds of West China Union University, in yard of temporary quarters of middle school, in line with southern side of building occupied as physics laboratory, and 70.1 feet (21.37 meters) east of southeast corner; marked by deeply set, red sandstone post, top of which is about 8 inches (20 cm.) square and marked by a pair of diagonal lines, set even with ground. True bearings: western edge of chimney on northwest corner of faculty residence No. 3 of Canadian Methodist Mission row, at its junction with roof of house, about 1,200 feet (0.4 km.), 26° 14′.0; tip of ornament on tower of student

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China—*continued.*

Chengtu, Szechwan, 1916—continued.
dormitory of Methodist Episcopal Mission, about 1,100 feet (0.4 km.), 233° 51′.1.

Chenki, Hunan, 1915.—On small island in Yuan River, about 3 miles southeast of Chenki, between south bank of river and a larger cultivated island with a small temple at its west end, about 30 feet (9.1 meters) from south side, and about 300 feet (91 meters) from west end of small island. True bearing: top of Chenki pagoda, 3 miles (5 km.), 111° 58′.8.

Chikow, Shansi, 1916.—On right bank of Yellow River, in province of Shensi, opposite Chikow in Shansi province, near foot of small ravine, and just east of terrace about 50 feet (15 meters) high, on which stand three buildings of temple, past which runs path from ferry, at a point in line of southern side of middle building projected eastward about 150 feet (46 meters). True bearings: southwest corner of most southern building in town, across river, about 1 mile (1.6 km.), 13° 17′.5; southeast corner of middle temple building, 3 feet (0.9 meter) above base, 141° 39′.7; northeast corner of northern temple building, 3 feet (0.9 meter) above base, 184° 23′.6; southeast corner of stone tower by road on cliff across river, about half mile (0.8 km.), 227° 37′.1.

Chinchowfu, Shengking, Manchuria, 1916.—Approximate reoccupation of station of 1907. East of Chinchowfu, on north bank of ancient intrenchment which meets cart road to Ichow about 1,020 paces north of a stone culvert through which it passes under railroad to Newchwang, 43 paces southeast of a point on bank in line with east edge of tomb of Buddhist priest, which stands north of intrenchment. True bearings: left gable end of mission residence, 2 miles (3 km.), 19° 47′.6; cross on Roman Catholic Mission church, 2 miles (3 km.), 28° 36′.8; staff on gate building in southeast corner of city, 3 miles (5 km.), 34° 09′.4; top of pagoda in city, 3 miles (5 km.), 43° 59′.4; right ornament on large temple, 3 miles (5 km.), 45° 42′.1.

Chingchun, Szechwan, 1916.—In back yard of large inn kept by a Mohammedan on north side of street in east suburb of city, 15 feet (4.6 meters), and 18 feet (5.5 meters) from east and north mud walls, respectively, and about 60 feet (18 meters) north of inn.

Chingkuoping, Shensi, 1916.—About midway up north slope of Hwashan, on grounds of Chintienkung temple, at a point just east of clump of six pine trees, and 4 paces west of a point on path 56 paces south of lowest step on south side of temple entrance. True bearings: edge of prominent corner on cliff at left side of deep ravine running northward down to plain, about three-fourths mile (1.2 km.), 164° 02′.9; peak of gable at south end of main building of temple, about 160 yards (146 meters), 193° 27′.7.

Choahr Ussu, Outer Mongolia, 1915.—Southwest of caravan road from Uliassutai to Paotowchow, in small oasis formed by small river known as Choahr Ussu, about 300 feet (91 meters) southwest of source of river, in low sand-hills southeast of river, about midway of first U-shaped bend of river below its source, and about 150 feet (46 meters) from each arm of bend. True bearing: center of top of small obo on low range, one-fourth mile (0.4 km.), 37° 48′.8.

Chockhurt-in Dava, Outer Mongolia, 1915.—In pass about 3 miles (5 km.) east of Chockhurt courier station on road from Urga to Uliassutai, about 150 feet (46 meters) north of road, on small flat bluff near foot of steepest part of pass, about 900 feet (274 meters) northeast of obo at summit of pass, whose approximate bearing is 47° 10′.

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China—*continued.*

Cholo Kobor, Chihli, 1915.—On hillside about 800 feet (244 meters) south-southeast of Cholo Kobor well, which is about 1 mile (1.6 km.) northwest of Mongol encampment, on main ox-cart road from Kalgan to Urga. True bearings: altar on distant hill, 5 miles (8 km.), 197° 52′.5; center of top of isolated rock on hill, half mile (0.8 km.), 270° 03′.5; altar on hill above encampment, 1.5 miles (2.4 km.), 315° 59′.8; conical peak in center of range, 15 miles (24 km.), 325° 01′.6.

Chüanchowfu, Fukien, 1917.—About one-fourth mile (0.4 km.) southwest of station of 1906, in recreation ground of middle school of English Presbyterian Mission, at kicking-off point in middle of football pitch, occupying main portion of ground, 214.8 feet (65.47) meters) southeast of southwest corner of east wing of middle school building, and 183.7 feet (55.99 meters) southwest of south corner of superintendent's residence; marked by cylindrical block of granite, 11 inches (28 cm.) in diameter and 7 inches (18 cm.) deep, with the top inscribed C. I. W., a cross indicating exact point, and set just below surface. True bearings: near gable end of prominent house, half mile (0.8 km.), 100° 35′.9; near gable end of west wing of school, 110° 28′.5; center gable of school, 122° 28′.7; left gable end of residence of superintendent, 214° 00′.1; bottom of flagstaff near gate, about 150 feet (46 meters), 309° 50′.7.

Chüchowfu, Chekiang, 1917.—In Martyrs' cemetery, a large walled garden on a low hill in city, near China Inland Mission station, on small lawn at northwest end of cemetery, 55 feet (16.8 meters) south of angle in north wall, and 48 feet (14.6 meters) northeast of center of footpath along southwest side of garden; marked by gray stone block, 6 by 6 by 21 inches (15 by 15 by 53 cm.), with top face left just below ground, and large cross cut to indicate exact point. True bearings: near gable end of white-fronted house visible through trees, half mile (0.8 km.), 84° 26′.9; near gable end of large temple building, one-fourth mile (0.4 km.), 111° 23′.9; top of north corner of cemetery wall, about 150 feet (46 meters), 143° 23′; top of near angle in northeast wall, 182° 26′.

Chükopu, Kansu, 1916.—Between and roughly in line with two lone trees on waste soda land, 51 paces from west bank of Yellow River, about one-third mile (0.5 km.) southeast of village temple, 72 feet (21.9 meters) from tree to northwest, 106 feet (32.3 meters) from tree to southeast. True bearings: near gable end of detached house at south end of village, 92° 59′.1; center ornament on roof of village temple, 117° 39′.8; bottom of tree to northwest, 127° 16′; near gable end of ruined temple on sandhills, three-fourths mile (1.2 km.), 143° 54′.2; near gable end of rear building of double-gabled temple, 1.5 miles (2.4 km.), 192° 24′.7; bottom of tree to southeast, 306° 36′; center of fort on range across river, 5 miles (8 km.), 336° 15′.9.

Chungchow, Szechwan, 1916.—On small sandy patch of shore, deeply covered at high water, between two prominent rocky sections of right bank of Yangtze Kiang, opposite city. True bearings: western edge of white wall of prominent temple on left bank of river just west of ravine at west end of city, 105° 21′.9; tip of five-story pagoda at east end of east suburb on left bank, above great ledge of rock obstructing river, 192° 32′.7.

Chungking, Szechwan, 1916.—In northwest corner of city, on plot of open cultivated ground, 57.7 feet (17.6 meters) south of western side of gateway at entrance to American consulate yard measured along a line perpendicular to outer face of wall. True bearings:

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Chungking, Szechwan 1916—continued. vertical diameter of central ridge-ornament on roof of Confucian temple, about half mile (0.8 km.), 250° 03′.2; tip of tower on Chinese building on verge of cliff on Yangtze Kiang side of city, about half mile (0.8 km.), 284° 19′.2.

Chungweihsien, Kansu, 1916.—On small mound in swampy ground about 300 feet (91 meters) east of southeast corner of city wall and about 600 feet (183 meters) south of mud wall bounding east suburb of city, 15 paces east of small path leading across swamp. True bearings: center ornament on roof of small temple, 600 feet (183 meters), 45° 18′.4; top of ornament on tower in southeast corner of city, 300 feet (91 meters), 84° 57′.6; near gable end of east gate building, 1,200 feet (366 meters), 153° 56′.6; center ornament on temple in suburb, 1,000 feet (305 meters), 202° 57′.6.

Chushangpu, Chekiang, 1917.—On left bank of Tsien Tang River, opposite small village of Chushangpu, which is about 8 miles (13 km.) below large market town of Lanchi, at a point about 500 feet (152 meters) below ferry landing, 12 paces southwest of southmost of 16 tallow trees lining bank of river, and 4 paces from top of left bank of river. True bearings: top of conical peak, 10 miles (16 km.), 261° 17′.9; top of distant pagoda, 5 miles (8 km.), 302° 53′.4; near gable end of northmost visible house of village, 317° 18′.1.

Dairen, Kwantung Leased Territory, Manchuria, 1916.—On forestry reserve on lower slopes of hills about half mile (0.8 km.) southeast of Japanese war memorial, about 1,000 feet (305 meters) east of main road leading from war memorial to pass over hills, about 400 feet (122 meters) south of stone dam running along base of hills, 112.5 feet (34.29 meters) south of concrete peg marked "Forestry Reserve" in Japanese, standing about 2 feet (0.6 meter) above surface of ground; marked by three red bricks placed together on end, with cross cut in center of top face and left just beneath surface of ground. True bearings: near gable end of shrine, 1 mile (1.6 km.), 79° 41′.8; top of dome of Yokohama Specie Bank, 1.5 miles (2.4 km.), 117° 32′.4; top of red brick tower, 3 miles (5 km.), 119° 21′.4; tip of war memorial, 133° 25′.4; top of Japanese survey station, 500 feet (152 meters), 170° 24′.6; top of near corner of concrete peg, 182° 22′; lighthouse at east end of breakwater, 3 miles (5 km.), 197° 31′.6.

Dolon-nor, Chihli, 1915.—South of city, in midst of sandy slopes covered with coarse grass lying between road from Kalgan and south entrance to city, about 45 paces from road, opposite point 100 yards (91 meters) southeast of junction of two branches from city. True bearing: vertical diameter of signal tower on hill, 338° 23′.8.

Eekhun Buyer Well, Outer Mongolia, 1915.—On level ground about 400 feet (122 meters) north of well which is between two low hills about 1,000 feet (305 meters) east of main ox-cart road from Kalgan to Urga.

Encampment, Shensi, 1915.—On north side of road to Yulinfu, in cultivated field, about 10 paces south of row of willow trees lining right bank of brook.

Erhshihlipu I, Shensi, 1915.—About 7 miles (11 km.) from Chingchenhsien, 50 feet (15.2 meters) west of road toward Yenanfu, about 1 mile (1.6 km.) south of first temple passed after leaving Chingchenhsien, near group of grave mounds and three trees. True bearings: vertical axis of route-marking mound on distant mountain top, several miles away, 1° 34′.6;

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Erhshihlipu I, Shensi, 1915—continued. vertical axis of route-marking tower on mountain top, about 2 miles (3 km.), 191° 18′.4; western side of lone building in mid-valley, about 1 mile (1.6 km.), 353° 15′.0.

Erhshihlipu II, Shensi, 1916.—About one-eighth mile (0.2 km.) south of village, near southeastern corner of sandy patch of river shore used as resting and watering place for camel trains, near mass of boulders bounding sandy patch on south, 32 paces northwest of center of pair of large mill-stones standing at outer corner of boulder-strewn area, and 12 paces west of center of large single rock half submerged, with large pits worn into its upper surface.

Errin Gosso, Inner Mongolia, 1915.—About 1 mile (1.6 km.) east of main east branch of ox-cart road from Kalgan to Urga, at a point where road leads through a pass between abrupt sandstone range of hills rising out of plain and where a small road branches off to the northeast, about 1,000 feet (305 meters) northwest of well and 4 paces north of northmost footpath leading to well.

Fanchiatun, Shengking, Manchuria, 1916.—About half mile (0.8 km.) south-southeast of railway station, about 700 feet (213 meters) south along Ping Chi Tai road from point of junction with main road to Kuo Chia Tun, on waste land just north of junction of Ping Chi Tai road and a road running to northeast, 12 paces west of Ping Chi Tai road, 3 paces east of edge of field, and 28 paces from north side of cross road to south. True bearings: solitary tree at junction of roads, 142° 39′; top of high flagmast in Japanese reserve, one-third mile (0.5 km.), 149° 59′.9; top of railway water-tower, 155° 29′.4; near gable end of Japanese building, 160° 39′.6; near gable end of white-fronted farmhouse, 1.5 miles (2.4 km.), 350° 40′.6.

Fengchen, Kweisuitao, 1916.—About 1 mile (1.6 km.) south of railway station, on waste grassy land, in line with two boundary stones marking southeast and southwest corners respectively of foreign graveyard of Swedish mission station, 38.5 feet (11.73 meters) west of latter. True bearings: bottom of left pillar of temple building, 1.5 miles (2.4 km.), 122° 38′.0; center of right gable end of Confucian temple, 181° 25′.1; right gable end of watch-tower on rightmost of two forts, 2.5 miles (4.0 km.), 193° 18′.3; near gable end of watch-tower in town, 211° 23′.7; center of top of left pillar of memorial arch, half mile (0.8 km.), 241° 24′.6; bottom of southwest boundary stone of foreign graveyard, 262° 06′.

Fenghsien, Shensi, 1916.—In east suburb, in wheat field south of principal inn on south side of street five doors from east end of suburb, at a point 51 feet (15.5 meters) south of center of narrow door in south wall of back yard of inn measured along a line perpendicular to wall. Magnetic bearings: tip of small tower at southeast corner of city wall, about one-sixth mile (0.3 km.), 46° 32′; left side of slit in higher inner rampart just south of tower over east gate of city, 83° 20′; right end of ridge of roof on tower over east gate, 86° 19′.2.

Fenghwangcheng, Shengking, Manchuria, 1916.—About in center of small triangular piece of grass-land on east bank of river, about half mile (0.8 km.) north of railway station, just west of a farming colony situated on west outskirts of Chinese town, and just north of grave land adjoining execution ground, 19 paces north of edge of road forming southeast side of triangle, 27 paces south of edge of road forming northeast side

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Fenghwangcheng, Shengking, Manchuria, 1916—continued. of triangle, 31 paces east of edge of old river bank forming west side of triangle. True bearings: center gable of railway station, 8° 32′.7; telegraph pole at right end of railway bridge, one-fourth mile (0.4 km.), 67° 58′.6; center ornament on leftmost temple building at foot of hill, 1.2 miles (1.9 km.), 166° 03′.7; lamp-post on bridge over river, half mile (0.8 km.), 328° 48′.2; right gable end of large iron shed, half mile (0.8 km.), 350° 53′.0.

Fengning, Chihli, 1915.—At western end of grove of small trees west of road leading to south gate of city, and in front of temple standing outside city walls west of south gate, 15 paces west of point in extension of line of great trees running south from corner of temple, 61 paces south of nearest of these trees; marked by conical hole cut in top face of irregular granite stone about 6 by 8 inches (15 by 20 cm.) in horizontal section, left about 2 inches (5 cm.) above ground. True bearing: top of pagoda on top of mountain about 3 miles (5 km.), 359° 34′.9.

Fohlokchuan, Shensi, 1915.—Opposite hill village of Fohlokchuan, 7 miles (11 km.) from Lochwan, 44 paces west of road to Chungpu, 18 yards (16 meters) and 20 yards (18 meters) from eastern and northern sides respectively of a rectangular burial-plot about 30 yards (27 meters) by 60 yards (55 meters), in northern half of which is one large grave mound and in southern half a small mound between two large ones. True bearing: vertical diameter of central tip on tri-headed gravestone, about one-fourth mile (0.4 kilometer), 246° 10′.2.

Foochow, Fukien, 1917.—Close reoccupation of station of 1906. On recreation ground within race-course in foreign settlement at Nantai, near north end of ground 119.5 feet (36.42 meters) south of southeast corner of small bridge over ditch inside race-course, 59 feet (18.0 meters) to center of main pathway crossing bridge measured along line joining posts at northeast and northwest turns of track, 71.7 feet (21.85 meters) northwest of nearer of two eucalyptus trees, and 98.3 feet (29.96 meters) southeast of hole No. 3 of golf-course; marked by granite block 7 by 8 by 10 inches (18 by 20 by 25 cm.) with top inscribed C. I. W. set just below surface. True bearings: bottom of flag-staff, about 500 feet (152 meters), 3° 31′.5; cross on south end of Trinity College chapel, 600 feet (183 meters), 162° 37′.6; bottom of south rail post on east side of small bridge, 175° 54′.9; southeast veranda post of pavilion, about 600 feet (183 meters), 357° 08′.5.

Fowchow, Szechwan, 1916.—On premises of Canadian Methodist Mission on hill south of city, about 75 feet (23 meters) west of bungalow occupied by Mr. Morgan, on next to lowest level in series of terraces, at a point in line with row of eucalyptus trees along middle of terrace, 7.0 feet (2.13 meters) south of center of south tree in row, 12.6 feet (3.84 meters) west of center of most southern tree in row at upper side of same terrace. True bearings: left edge of right pillar of temple structure on slope of mountain on opposite bank of Yangtze Kiang, about 1 mile (1.6 km.), 160° 03′.7; outer edge of brick pillar at north end of front veranda of Morgan bungalow, 226° 54′.2; outer edge of brick pillar at south end of front veranda of Morgan bungalow, 284° 05′.6.

Fuchow Ki, Kiangsi, 1917.—Near southeast corner of large private garden across street from entrance to church compound of American Methodist Mission, in city, at a point 38 feet (11.6 meters) west of mud

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Fuchow Ki, Kiangsi, 1917—continued. wall bounding east side of garden, 72 feet (21.9 meters) northwest of northwest pillar of pigsty in southeast corner of garden, and 60.5 feet (18.4 meters) north of south mud wall of garden. True bearings: left gable end of brick building, about 100 feet (30 meters), 23° 59′.4; top of cross on gate of mission station, about 130 feet (40 meters), 61° 05′.4; top of tower of mission church, 400 feet (122 meters), 70° 26′.7; top of north end of roof of gate-house of garden, 100 feet (30.5 meters), 103° 22′.2; top of near end of high wall, about 250 feet (76 meters), 181° 04′.7.

Funingfu, Fukien, 1917.—In northwest quarter of city, in grounds of Government Middle School, which is just east of mission station of Church Missionary Society, in about center of recreation-ground, between north wall of city and school-compound, 143 feet (43.6 meters) from city wall, 119 feet (36.3 meters) from west mud wall of recreation ground, and 146 feet (44.5 meters) northwest of west side of back gate of school. True bearings: near gable end of mission residence, about 400 feet (122 meters), 82° 45′.3; top of pagoda on hill, one-fourth mile (0.4 km.), 105° 13′.0; northeast corner of recreation-ground, 223° 26′.5; near roof scroll of north gate of city, one fourth mile (0.4 km.), 241° 16′.1; top of pagoda, 4 miles (6 km.), 287° 22′.2; southeast corner of recreation-ground, 292° 08′; west side of back gate of school, 337° 24′.9.

Funinghsien, Chihli, 1916.—On grass-land about one-fourth mile (0.4 km.) northeast of northeast corner of city wall, within angle formed by two cart tracks, to northeast and southeast respectively, just east of their junction with main road north from city and east suburb, about 500 feet (152 meters) north of wooded graveyard containing a big tomb, 6 paces from edge of bank of field to southwest, 11 paces from edge of field to northwest, and 4 paces from edge of field to east. True bearings: top near corner of first buttress on east city wall, one-third mile (0.5 km.), 36° 00′.4; northeast corner of city wall, one-fourth mile (0.4 km.), 48° 59′.2; near gable end of temple on steep crag, 7 miles (11 km.), 71° 37′.9; near gable end of temple in east suburb, one-fourth mile (0.4 km.), 347° 42′.6; top of ornament on right end of front long building of temple, one-fourth mile (0.4 km.), 350° 35′.1.

Futuyü, Chihli, 1915.—On left bank of stream, about opposite village and ruins of a tower in second terrace of cultivated fields, near north end of oval grassy hillock, nearly in line with bridge; marked by conical hole cut in top of a small boulder placed with top about 4 inches (10 cm.) above ground. True bearing: south corner of lowest of three watch towers on right bank of stream, at level where brick and granite meet, about 1 mile (1.6 km.), 237° 15′.5.

Gol Derris, Inner Mongolia, 1915.—On low sand-hill, 29 paces southwest of main east branch of ox-cart road from Kalgan to Urga, about one-fourth mile east of Gol Derris Encampment, and about 150 feet (46 meters) southeast of camping place for caravans which is marked by soakage holes dug in sand for water. True bearing: top of altar on hill, three-fourths mile (1.2 km.), 319° 31′.

Goosut Ussu, Outer Mongolia, 1915.—Between eighth and ninth courier stations on Urga to Uliassutai courier road in region known as Seerting Dava, about 300 meters north of road, about 3 paces southwest of cattle pad which descends from southeast to small river

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Goosut Ussu, Outer Mongolia, 1915—continued. which here flows eastward from spring at edge of swamp about 300 meters farther west, about 150 feet (46 meters) from south bank of river known as Goosut Ussu.

Gusson Togurik, Outer Mongolia, 1915.—On main road from North Mongolia to Alashan yamen, about 7 miles (11 km.) north of boundary between Outer and Inner Mongolia, at north end of sandy valley, half mile (0.8 km.) northeast of well known as Gusson Togurik, among sandy hillocks.

Haichalu, Shensi, 1915.—On sloping, sandy, left bank of stream, about opposite north end of village, and 15 paces southeast of base of high stone cliff; marked by conical hole in top of small boulder, top face of which is about 4.5 by 3 inches (11 by 8 cm.), with rounded corners, left nearly flush with ground and covered with pile of flat stones. True bearing: left-hand edge of ornament on north gable end of roof of wayside shrine, one-sixth mile (0.3 km.), 259° 33′.4.

Haicheng, Shengking, Manchuria, 1916.—In southwest corner of execution ground, on right bank of Sha River, about one-fourth mile (0.4 km.) along road leading northwest from west gate of city, at a point 86 paces from hedge bounding ground on northwest, 27 paces from westmost bush on river bank, and 44 paces from tree to northeast. True bearings: left gable end of house across river near ford, 39° 31′.9; right gable end of gray house across river, 71° 06′.4; left gable end of long farmhouse, one-third mile (0.5 km.), 112° 44′.6; left side of brick pagoda grave, 500 feet (152 meters), 258° 56′.7; top of right side of factory chimney, one-third mile (0.5 km.), 309° 30′.2; telegraph pole on southwest corner of city wall, 315° 35′.0.

Hailar, Heilungkiang, Manchuria, 1916.—In southeast corner of grassy plateau bounded by railway on north and line of tree-covered sand-hills on south, 1 mile (1.6 km.) south-southwest of railway water-tower, about 600 feet (0.2 km.) west-southwest of old Russian cemetery, 112 feet (34.1 meters) west of northmost of three pine trees growing together, 86 feet (26.2 meters) from nearest tree to south, 252.5 feet (76.96 meters) from edge of trench to north, 653.5 feet (199.19 meters) southeast of northwest corner of cemetery fence; marked by round wooden post, 8 by 25 inches (20 by 64 cm.) set just below surface. True bearings: bottom of funnel on top of small water-tower, 1 mile (1.6 km.), 184° 54′.6; cross on tower of church, 1.5 miles (2 km.), 193° 16′.6; top of railway water-tower, 199° 01′.5; top of wooden pyramidal shelter at right end of railway bridge, 2 miles (3 km.), 212° 48′.4; top of northwest corner of cemetery fence, 240° 30′.1; cross on stone monument in cemetery, 256° 19′.7; bottom of rightmost graduate pole of temple, one-third mile (0.5 km.), 312° 02′.8.

Hallchin Holer, Outer Mongolia, 1915.—About 1,000 feet (305 meters) northeast of main ox-cart road from Kalgan to Urga where it skirts west end of a chain of lakes and marshy ground, on small piece of level ground at east end of small lake, about 13 paces from edge of high grass-land bordering lake, about 200 feet (61 meters) southeast of pole in a cairn of rocks which is visible from main road and marks watering place. True bearings: bottom of pole in cairn, 129° 15′.3; top of end conical peak of range, 15 miles (24 km.), 163° 16′.9.

Hanchungfu, Shensi, 1916.—Near middle of vegetable garden about 60 yards (55 meters) square belonging to China Inland Mission in northwest quarter of city, just east of mission residences and south of chapel, at a point in line of north side of gateway between residence compound and garden, 36 paces, 31 paces, 28 paces, and 29 paces respectively from north, east, south, and west walls of garden, 13 paces from center of circular well-curb between two large trees. True bearings: southeast corner of Rev. Goold's residence at level of second floor, 124° 22′.3; southwest corner of chapel at 18 inches (46 cm.) above ground, 149° 54′.0.

Hangchow, Chekiang, 1917.—Reoccupation of station of 1906, in grounds of custom-house at intersection of path which runs parallel to easterly side of custom-house with path which enters gate to commissioner's residence; 90.2 feet (27.5 meters) measured in a southerly direction along path from a point on line of south side of custom-house produced 8 feet (2.4 meters) from southeast corner; station of 1906 was marked by cross cut in top of a stone sunk nearly flush with ground; at this occupation the precise point was found to be midway of edge of stone about 4 inches (10 cm.) north of cross. True bearings from point 4 inches (10 cm.) north of cross: bottom of southeast corner of custom-house, 168° 46′.3; bottom of northwest corner of central chimney on residence of indoor staff of customs, 200 feet (61 meters), 194° 12′.4; near gable end of large gray brick building, half mile (0.8 km.), 329° 23′.1.

Hankow, Hupeh, 1916.—Close reoccupation of station of 1907, in central field of race-course, which lies back of eastern end of German concession, near northwestern side of course, west of golf course, 25 paces northeast of inner corner of steeple-chase hurdle near half-mile post, and 32 paces east of a point on inner rail of trial track measured toward half-mile post; marked by conical hole half inch (1 cm.) in diameter in top face of stone whose exposed portion measures 8 by 8 by 8 inches (20 by 20 by 20 cm.), embedded below ground in block of concrete, top face of stone being marked C. I. W., 1916, M. Sta. True bearings: center-line of half-mile post at base, 99° 22′.5; tip of cupola on club-house, 340° 00′.2; tip of cupola on stable, 358° 30′.2.

Hankuai Ferry, Yunnan, 1917.—On sandy bed under north bank of Salween River, just west of Hankuai Ferry crossing, about 200 feet (61 meters) west of and below ferryman's hut, 10 paces from bottom of rocky north bank.

Hanshihling, Chihli, 1915.—On north side of pass, on southern slope of small gully 192 paces down main road from north wall of hamlet at summit, and 50 paces up gully eastward from road. True bearings: shoulder of prominent mountain peak, 175° 47′.7; mountain shoulder, 186° 21′.4.

Haragan Jeerum Well, Outer Mongolia, 1915.—About one fourth mile (0.4 km.) north of main ox-cart road from Kalgan to Urga, south of small mound near southwest corner of a long bare sandy flat, about 400 feet (122 meters) southeast of Haragan Jeerum well, and about 300 feet (91 meters) east of small road leading from main road to well.

Harbin, A, Kirin, Manchuria, 1916.—At Old Harbin, at east end of Russian public park, in west half of small open space surrounded by trees in form of a rough square, adjoining central garden of park in which is bandstand and various summer houses, 11.5 feet (3.50 meters) west of footpath running diagonally across open space, 221 feet (67.4 meters) northwest of tele-

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Harbin, A, Kirin, Manchuria, 1916—continued. phone-pole in southeast corner of park, and 41 feet (12.5 meters) from nearest tree to north; marked by a concrete post about 8 inches (20 cm.) square, with top inscribed C. I. W., 1916, with a drill hole indicating the exact point, and also an inscription in Russian, explaining meaning of post, left about 3 feet (0.9 meter) above ground. True bearings: bottom of double pole to left of wooden building, half mile (0.8 km.), 285° 03′.5; left gable end of wooden building visible through gate in east wall of park, 285° 18′.2; bottom of telephone-pole, 296° 44′.0.

Harbin, B, Kirin, Manchuria, 1916.—Close reoccupation of Russian observing point in 1909, at Old Harbin, at east end of Russian public park, in southeast corner of square-shaped open space, 111.7 feet (34.05 meters) west-southwest of Harbin, *A*, 30 feet (9.1 meters) from nearest tree to east, 35.5 feet (10.82 meters) from nearest tree to west, 54.7 feet (16.67 meters) northeast of south support of seat at junction of paths, 11 feet (3.4 meters) from edge of path to northwest, and 13 feet (4.0 meters) from edge of path to south. True bearings: bottom of rightmost veranda post of pavilion, 250 feet (76.2 meters), 90° 04′.8; bottom of old electric-light post, 200 feet (61.0 meters), 131° 45′.4; post marking C. I. W. station, *A*, 203° 03′.7; top of ornamental post visible through gate, half mile (0.8 km.), 259° 54′.4.

Hengchowfu, Hunan, 1915.—Close reoccupation of station of 1907 designated Hengchow, on small strip of level land forming top of cemetery, north of American Presbyterian Mission compound, northwest of Boatmen's temple, and 400 feet (122 meters) north of boys' mission school building; marked by rough stone block 6 by 7 by 18 inches (15 by 18 by 46 cm.) projecting 2 inches (5 cm.) above ground. True bearings: tip of ornament at left end of roof of boys' school, 400 feet (122 meters), 1° 07′.1; near gable end of roof of missionaries' residence, 400 feet (122 meters), 28° 36′.5; top of cross at north end of roof of Roman Catholic church, one-third mile (0.5 km.), 43° 23′.9; top of right edge of large gray house, 1,000 feet (305 meters), 54° 41′.6; left gable end of large building, 900 feet (274 meters), 71° 29′.1; top of center ornament on roof of temple, 600 feet (183 meters), 103° 50′.1; center ornament on gate-house of Government buildings, 1 mile (1.6 km.), 161° 37′.5; top ornament on pagoda on hill, 1,000 feet (305 meters), 258° 11′.1; center ornament over gate of college across river, 1 mile (1.6 km.), 289° 30′.4.

Hochow Kan, Kansu, 1916.—Near northeast corner of city, back of barracks of Hsien yamen, about 150 feet (46 meters) west of rear yamen building, about 500 feet (152 meters) southeast of gate building in north wall of city, 91 feet (27.7 meters) northwest of northeast corner of wall of barracks, and 89 feet (27.1 meters) northeast of northwest corner. True bearings: near gable end of small gate house, 120 feet (36.6 meters), 14° 45′.5; center of near ornament on temple, 500 feet (152 meters), 41° 58′.3; left ornament on roof of north gatehouse, 136° 16′.0; near gable end of rear yamen building, 277° 30′.3; northeast corner of wall of barracks, 314° 06′.

Hokei, Kansu, 1916.—In northwest corner of small strip of waste land, 145 feet (44.2 meters) north 22° 21′ east of northeast corner of mud-walled fort of village. True bearings: center of obo on mountains, 2 miles (3 km.), 16° 56′.6; right door post of temple, 1,200 feet (366 meters), 131° 15′.2; top of center ornament on temple, 600 feet (183 meters), 306° 03′.1; bottom of leftmost support of house in southeast corner of fort, 400 feet (122 meters), 359° 13′.0.

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Hokow, Shansi, 1916.—West of town, on west side of canal, nearly opposite inn known as "Chung Lung Tien," and southeast of small gray brick shrine standing on raised ground amid large trees, 57 paces northward along canal bank from point directly opposite inner edge of northern side of west door to Chung Lung inn, and 42.5 paces southward along canal bank from a point on continuation of line of south side and 13.5 paces east of continuation of line of east side of brick shrine. True bearings: southeast corner of brick shrine, 127° 25′.8; vertical axis of central ornament on ridge of temple roof in town, about half mile (0.8 km.); 153° 52.0; left inner edge of back door of "Chung Lung Tien," 287° 03′.5; angle in long mud wall across canal, about half mile (0.8 km.), 315° 49′.3.

Homushu, Yunnan, 1917.—About 265 paces northeast of first inn on left as village is entered from south, 225 paces along small path which leaves main road about 40 paces east of inn, on small open shelf about 50 feet (15 meters) east of pond, 23 paces south of large forked tree, and 16 paces from tree standing on slope toward southeast. True bearings: center ornament on temple across valley, 6° 33′.6; center of grave northwest of pond, 158° 51′; fork in large tree, 205° 51′.7.

Hongkong Observatory, Hongkong, 1915.—The north and south observatory piers in observing hut and an outside station in line with piers. The outside or tent station *B* is 47.0 feet (14.33 meters) south of *South Pier* or *A′* in line with azimuth mark across harbor, and 55.38 feet (16.88 meters) south of *North Pier* or *A* in same line. These are same stations as were used in 1906, 1907, 1908, and 1911. The observatory is on a hill nearly in center of Kowloon, which is on mainland just across bay from Hongkong.

Hsiung Wan Ku Tsun, Ordos, Inner Mongolia, 1916.—On waste land east of district magistrate's office, a small mud-walled compound on main road, in line with south wall, 138 feet (42.1 meters) from southeast corner and 168 feet (51.2 meters) from northeast corner of wall of compound, 16 feet (4.9 meters) north of edge of ditch. True bearings: southeast corner of compound wall, 88° 59′; near gable end of small temple within compound, 116° 25′.8; northeast corner of compound wall, 124° 46′; left gable end of small mud temple within compound, 1,500 feet (457 meters), 191° 59′.6.

Huangyang Motto, Ordos, Inner Mongolia, 1916.—In north end of Roman Catholic Mission station compound, in center of raised avenue running from church to north wall, about 230 feet (70 meters) southwest of northeast corner of compound wall, 147 feet (44.8 meters) south of north wall of compound; marked by cross cut in two gray bricks placed together on end, with top faces left 1 inch (3 cm.) below ground. True bearings: bottom of near side of cross on front of church, 450 feet (137 meters), 8° 31′.8; bottom of right edge of right chimney on residence, 27° 01′.7; northeast corner of mission compound, 237° 14′.

Hungmachia, Inner Mongolia, 1916.—South of Kalgan to Kanchow caravan road, south of four small sand hummocks, about 500 feet (152 meters) southeast of most southerly of the settlers' houses.

Hungtuling, Shansi, 1916.—On sandy, grass-covered knoll west of west end of village and north of road to Sopingfu, 6 miles (10 km.) southeast of Sopingfu on road from Tatungfu, at a point 76 paces west of north corner of stone-faced buttress of village wall, 38 paces north of northern end of low mud wall projecting northeast from road just outside village entrance,

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Hungtuling, Shansi, 1916—continued.
measured toward an isolated mound about 100 yards (91 meters) to north. True bearings: most southerly visible tower of great wall on mountain ridge, about 10 miles (16 km.), 64° 34′.7; most northerly visible tower of great wall on distant mountain ridge, 141° 41′.6.

Hushurt Hottock, Outer Mongolia, 1915.—On stony plain about half mile (0.8 km.) east of Hushurt Hottock or "Enclosed Well" on main road from Lama Gegen province to Alashan yamen. True bearing: top of conical peak of range, 15 miles (24 km.), 352° 25′.2.

Hushurt-in Sire, Outer Mongolia, 1915.—About 2 miles (3 km.) east of Joss Olang Hottock, about 300 feet (91 meters) north of spring known as Hushurt-in Sire, 40 paces north of road from Gardin Gol to Province Jassaktu Khan, and 16 paces west of rocky outcrop.

Ichang, Hupeh, 1916.—Two stations, designated *A* and *B*, were occupied. Station *A* as occupied in November 1916, is about 20 feet (6 meters) west of station as occupied in April 1916, and is on a large level tract belonging to railway company east of city, 600 feet (182.8 meters) east of southeast veranda post of railway station; chief engineer to mark station by a concrete block with top face left several inches above ground and lettered C. I. W. 1916, with a drill hole indicating exact center. True bearings: north end post of meridian line, about 800 feet (244 meters), 81° 33′.3; outer edge of southeast veranda post of railway station, 86° 06′.3; left edge of left chimney at south end of roof of railway station, 88° 10′.4; outer edge of northeast veranda pillar of railway station, 106° 09′.1; left edge of long tenement building, half mile (0.8 km.), 134° 52′.1; top of eaves ornament on near gable end of temple on hill, half mile (0.8 km.), 267° 25′.8.

Station *B* is about half mile (0.8 km.) south of station *A* in compound of American Church Mission, about midway along south edge of playing field and west of chapel, 170 feet (51.8 meters) southwest of northwest corner of chapel at a point 3 feet (0.9 meter) above ground, 165.7 feet (50.50 meters) west-southwest of southwest corner of chapel at a point 3 feet (0.9 meter) above ground and 3.2 feet (0.98 meter) north of north edge of path leading from chapel to west gate of compound; marked by gray stone block 7 by 8 by 24 inches (19 by 22 by 61 cm.) with top face inscribed C. I. W., 1916, with a drill hole indicating the exact point, and left flush with surface of ground. True bearings: flagstaff on tower of railway administration building, half mile (0.8 km.), 176° 50′.6; near gable end of railway building north of railway station, half mile (0.8 km.), 180° 49′.4; bottom of left edge of white chimney on German consulate, 1,000 feet (305 meters), 217° 29′.0; bottom of northwest wall of chapel, 232° 18′.9; bottom of southwest wall of chapel, 256° 31′.8; top of right edge of right chimney of missionary's residence, about 240 feet (73 meters), 285° 33′.2.

Ichenghsien, Hupeh, 1916.—On right bank of Han River, about 1 mile (1.6 km.) up-stream from boat mooring, on tow-path at edge of cultivated fields. Ture bearing: tip of ornament at nearer gable end of small temple in grove of trees, about half mile (0.8 km.), 91° 54′.8.

Illice-in Honkor Well, Inner Mongolia, 1916.—South-southwest of Shartzan Soom about 2½ days' journey, about 50 meters east of well known as Illice-in Honkor, or "The Hollow in the Sands."

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Imienpo, Kirin Manchuria, 1916.—About half mile (0.8 km.) north-northwest of railway station, on cleared land just northwest of Cossacks' barrack inclosure, exactly in line with south side of low circular-roofed concrete shed, 381.5 feet (116.28 meters) east of its southeast corner, 482 feet (146.9 meters) north of west corner of fence around Cossacks' barracks, 117 feet (35.7 meters) west of nearest tree; marked by wooden post, 4 by 4 by 30 inches (10 by 10 by 76 cm.) with cross on top face, left just below ground. True bearings: bottom of chimney of factory, one-fourth mile (0.4 km.), 16° 22′.9; bottom of signal arm on railway, half mile (0.8 km.), 73° 30′; southeast corner of circular-roofed shed, 78° 24′.1; bottom of nearby tree, 273° 47′.9; right gable end of roof of house, 307° 29′.5; bottom of wind-vane post at meteorological station, one-fourth mile (0.4 km.), 352° 11′.0; bottom of west corner of white fence around barracks, 352° 58′.

Island Hwang Ho, Shansi, 1916.—On large island covered with thin growth of cattails, about midstream in Yellow River, the second large island below Yümenkow in western channel, at a point about 70 feet (21 meters) east of western side of island, about midway of its length. True bearing: tip of a pagoda on bluff of east bank of river, about 1.5 miles (2.4 km.), 340° 19′.6.

Iyang Ki, Kiangsi, 1917.—About 2 miles (3.2 km.) north of city, over northwest corner boundary stone of new Christian cemetery of China Inland Mission, a red sandstone block projecting 8 inches (20 cm.) above ground and marked China Inland Mission in Chinese characters, a large cross cut in top face of stone marks exact instrument center. True bearings: tangent to convex outline of steep cliff, 5 miles (8 km.), 13° 36′.3; middle of square gravestone, about 400 feet (122 meters), 25° 31′.5; scroll at left end of roof of temple, one-fourth mile (0.4 km.), 47° 25′.2; right edge of small square stone building next to farmhouse, 900 feet (274 meters), 336° 19′.5.

Jaochow, Kiangsi, 1917.—Outside and northwest of city, just northeast of small leper village on north bank of old moat outside north wall of old city of Jaochow, about one-third mile (0.5 km.) west-northwest of north gate, on flat piece of grass-land on crest of low grave-hill, about 400 feet (122 meters) northeast of northmost house of leper village, and 18 paces north-east of footpath. True bearings: top of ornament on pagoda tower, one-third mile (0.5 km.), 3° 28′.3; center roof ornament on green-roofed temple, one-third mile (0.5 km.), 10° 34′.9; near gable end of roof of northmost house of leper village, 58° 12′.7; near end of roof ridge of China Inland Mission school, one-third mile (0.5 km.), 311° 01′.5; cross on tower of Roman Catholic church, 1.5 miles (2.4 km.), 315° 32′.3; top of old pagoda in old city, half mile (0.8 km.), 336° 02′.0.

Jeerum, Outer Mongolia, 1915.—Along road from Urga to Barron Kurin, about 90 paces west of junction of main road with small road entering it from southwest, about 17 paces south of main road and about 14 paces north of small road.

Junghsien, Szechwan, 1916.—On premises of Canadian Methodist Mission, about 100 feet (30 meters) south of front of residence occupied by Rev. W. E. Sibley, on line joining east and west posts of tennis court, 12 feet (3.7 meters) east of face of west post. True bearing: central vertical spike of central ornament on ridge of tower over west gate of city, about one-fourth mile (0.4 km.), 358° 10′.

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Kaihwafu, Yunnan, 1917.—On military parade-ground, about three-fourths mile (1.2 km.) northwest of west gate of city, about 13 feet (4 meters) west of bank along east boundary of ground, 75 paces east of path along west edge, 232 feet (70.7 meters) north-northwest of northeast corner and in line with east wall of pavilion at south end of grounds, 209 feet (63.7 meters) north of northeast corner of small stone tower; marked by two gray bricks placed side by side, with cross cut in top face and left just beneath surface of ground. True bearings: bottom of tree on small stone tower, 10° 58′; center ornament of temple in village, 23° 16′.3; ornament on right end of boundary wall at north end of ground, 155° 43′.2; near gable of fort on hill, 292° 09′.5; top of pagoda tower outside of city, threee-fourths mile (1.2 km.), 323° 16′.2; top of tower at northwest corner of city wall, 1 kilometer, 330° 53′.2; northeast corner of pavilion, 336° 21′.8.

Kaiyüan, Shengking, Manchuria, 1916.—In extreme northeast of town site at Kaiyüan railway station, about one-third mile (0.5 km.) northeast of Japanese school, a long gray building with many chimneys, on same street with a large Chinese theater, on strip of grassland between eastmost road and a cultivated field, 473 feet (144.2 meters) north-northeast of a concrete boundary pillar standing about 10 feet (3 meters) above ground, at junction of roads, marked with Japanese characters, 134.5 feet (41.00 meters) east of northeast corner of a small wooden culvert across road, 275 feet (83.8 meters) east-southeast of northeast corner of fence around small farm across road, and 22 feet (6.7 meters) west of middle of footpath. True bearings: electric-light post at end of street, 9° 33′.0; top of boundary pillar, 12° 15′.6; spike on near end of Japanese school, 79° 04′.6; near gable end of mud house, 111° 37′.7; bottom of right upright of cover over public well, 130° 09′.2.

Kalgan, Chihli, 1915, 1916.—Station of 1915, exactly reoccupied in 1916,is close reoccupation of Fritsche No. 396. In compound of former mission of Russian Greek church, now in ruins, which is located about 1 mile (1.6 km.) beyond north gate of city on west side of main road to pass into Mongolia, about one-fourth mile (0.4 km.) north of Russian post-office, in open space in northern half of compound, in line with south edge of square stone platform of former kiosk, 33.2 feet (10.12 meters) east of southeast corner; marked by cross cut in top face of block of three large gray bricks cemented together and left about 2 inches (5 cm.) above ground. True bearings: vertical axis of Chinese character "tai" on white wall of building across valley, one-fourth mile (0.4 km.) 271° 40′.1; near gable end of small temple on hillside, one-fifth mile (0.3 km.), 274° 04′.7.

Kanfang, Yunnan, 1917.—On waste grassy land about 500 feet (152 meters) northwest of and below northmost section of village, about 200 feet (61 meters) north of isolated house built on large mound, 39 paces northeast of bank bounding rice fields, 51 paces west of irrigation ditch. True bearings: bottom of tall tree on ridge, half mile (0.8 km.), 17° 32′.7; bottom of solitary tree on small rounded hill, one-fourth mile (0.4 km.), 22° 19′.3; near gable of northmost house of village, 295° 44′; near gable end of isolated house on large mound, 347° 38′.3.

Kaomiaotzu, Kansu, 1916.—In west corner of large mud-walled garden owned by Mr. Yeh, proprietor of last inn on main road to Siningfu outside west gate of village, about 700 feet (213 meters) west of west gate, 42.8 feet (13.05 meters) from tree in west corner of inclosure, 41.8 feet (12.74 meters) from southwest wall, and 36 feet (11.0 meters) from northwest wall. True bearings: old fort on hill, 2 miles (3 km.), 77° 47′; tree in northwest corner of garden 100° 23′; north corner of garden, 222° 11′; center ornament on ornamental tower on main road, 600 feet (183 meters), 262° 50′.8.

Kaopeitien, Chihli, 1915.—About 200 yards (183 meters) east of railway depot on cultivated land between east side of a prominent stone grave-monument, and east pedestal of a stone arch monument farther south, and 29.2 feet (8.90 meters) north of north face of arch. True bearings: vertical axis of top of railroad water-tank, about one-fifth mile (0.3 km.), 61° 58′.8; tip of most distant railroad signal-post visible, about 1 mile (1.6 km.), 202° 40′.6.

Kaying, Kwangtung, 1917.—On hill slope just northwest of American Baptist Mission compound at Vatli, about 3 miles (5 km.) northeast of city, 43 paces northwest of northwest corner of compound wall, 19 paces northwest of front of old grave, and 23 paces east of path along bank of pond west of compound. True bearings: near gable end of large house in village on hillside, one-third mile (0.5 km.), 16° 59′.7; center of doorway of large white tomb on opposite hill, one-fifth mile (0.3 km.), 102° 47′.9; near gable end of large prominent house in village, half mile (0.8 km.), 191° 23′.9; right gable end of house, about 250 feet (76 meters), 197° 03′.3; ornament at left end of large white house in group, one-third mile (0.5 km.), 275° 16′.0; top of near end of grave, 296° 08′.4.

Kiangtsing, Szechwan, 1916.—On foreshore on southside of Yangtze Kiang, about 1,000 feet (0.3 km.), northwest of northeast corner of city wall, and about 300 feet (91 meters) north of north edge of broken lumpy ground covered with grass, west of ferry.

Kiatingfu, Szechwan, 1916.—On premises of Canadian Methodist Mission, about 100 yards (91 meters) south of residence of Rev. Quirmbach and 6 inches (15 cm.) south of a point on continuation of back line of tennis court 13 feet (4.0 meters) from its southeast corner. True bearings: vertical diameter of ornament at middle of ridge of roof of ancestral temple of Li family, standing just northwest of residence occupied by unmarried ladies of mission, 71° 28′.5; southwest corner of residence of Rev. Quirmbach, at level of second floor, 179° 59′.3; northeast corner of residence, 202° 26′.0.

Kienchangfu, Kiangsi, 1917.—On left bank of Fu River, about half mile (0.8 km.) below east gate of city and one-fourth mile (0.4 km.) east of north gate, on waste land just northwest of Wang Shu Chia Miao, an isolated temple on river bank, 121 feet (36.9 meters) from north corner and 231 feet (70.4 meters) from east corner of temple, and 53 feet (16.2 meters) southwest of north corner of low brick wall around temple yard. True bearings: near end of roof of east gate of city, 14° 53′.4; near end of roof of north gate, 90° 27′.7; near end of roof of nearest house in village to northwest, 136° 49′.1; top of pagoda on hill, 2 miles (3.2 km.), 209° 14′.2; right edge of house on river bank, 600 feet (183 meters), 235° 29′.3; near corner of wall of temple yard, 247° 10′; near end of roof ridge of front temple building, 319° 06′.7; near gable end of rear temple building, 345° 10′.7.

Kinchow, Kwantung Leased Territory, Manchuria, 1916.—About half mile (0.8 km.) north of east gate of city, at west end of a strip of waste land, bounded on south

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Kinchow, Kwantung Leased Territory, Manchuria, 1916—continued.
by north bank of a dry sandy river bed, and on west and north by a copse which extends to base of hill on which is situated Japanese war memorial, about one-fourth mile (0.4 km.) south of war memorial, about 150 feet (46 meters) north of north bank of river bed, and about 150 feet (46 meters) east of west end of waste land. True bearings: near gable end of stone house across river, 600 feet (183 meters), 17° 38'.9; bottom of left edge of Japanese war memorial, 180° 17'.5; top of survey station on hill, 5 miles (8 km.), 262° 29'.3.

Kingyüan, Kwangsi, 1915.—On a piece of common land about one-third mile (0.5 km.) along main road west of west gate of city, 121 feet (36.9 meters) north of road, 163 feet (49.7 meters) west of north end of mud wall bounding tract on east, about 400 feet (0.1 km.) northwest of Wong's temple, being in line with three ornaments on roof; marked by round wooden stake 3.5 inches (9 cm.) in diameter set even with surface. True bearings: right gable end of large brick building, three-fourths mile (1.2 km.), 13° 39'.0; left side of window of gate-house, 600 feet (0.2 km.), 103° 37'.8; center ornament of temple on cliff side, 1200 feet (0.4 km.), 191° 26'.3; near gable end of temple on hill, three-fourths mile (1.2 km.), 241° 22'.8; near gable end of center temple building, 500 feet (152 meters), 283° 36'.1; front spike on roof of Wong's temple, 321° 22'.6.

Kirin, Kirin, Manchuria, 1916.—On south bank of Sungari River, opposite a sawmill across river at east end of Kirin, on rough grass-land, about one-fourth mile (0.4 km.) west of Hsi Ka Chi Kai ferry crossing, about 600 feet (183 meters) northwest of a small farmhouse on river bank, 82 paces south of cart track running along edge of grass-land, and 31 paces from path bounding field to south. True bearings: top of tower of large red brick building, 1.5 miles (2.4 km.), 111° 24'.4; top of pavilion on hills, 4 miles (6 km.), 141° 41'.0; staff on dome of Provincial Assembly building, 1 mile (1.6 km.), 151° 32'.8; center of ornament on left end of roof of Confucian temple, half mile (0.8 km.), 166° 39'.3; bottom of chimney stack of sawmill on opposite bank, 185° 34'.1; top of tall brick chimney of gunpowder factory, 1.5 miles (2.4 km.), 257° 38'.1; near gable end of mud building at farmhouse, 302° 59'.7.

Kishan, Shensi, 1916.—Two stations were occupied. Station *A* is in west suburb on south side of street, in inclosed back yard of inn with mud walls, on east, south, and west sides of which are cultivated fields and on north a row of inn rooms with mud walls and thatched roofs overlaid with clay tile, 36 feet (11.0 meters), 22 feet (6.7 meters), 37 feet (11.3 meters), and 37 feet (11.3 meters) from north, east, south, and west walls of yard, respectively. True bearings: left side of base of tall pole on high mud wall across valley, about 600 yards (0.5 km.), 41° 01'.6.

Station *B* is in south corner of yard, 31 feet (9.4 meters) south of station *A*, 5 feet (1.5 meters) west of southern part of east wall of yard, and 6 feet (1.8 meters) from south wall.

Kiungchow, Szechwan, 1916.—In southeastern quarter of city, on open grass plot south of Hsiao Hsiu yamen and west of entrance to Confucian temple, between door screen of yamen and low red sandstone parapet, north of large semicircular pond constructed in connection with temple, 26 feet (7.9 meters) south of door screen, 10.5 feet (3.20 meters) north of north face of parapet, and about 51 feet (16 meters) west of entrance to Confucian temple ground. True bearings: tip of pagoda on Peishan, 2 miles (3 km.), 7° 56'.1; tip of Kiungchow white pagoda, 3 miles (5 km.), 321° 50'.3.

Kowpangtze, Shengking, Manchuria, 1916.—On waste land along bank of a sandy river bed, 813 feet (247.8 meters) west-northwest from west corner of railway-station reserve or 624 feet (190.2 meters) from point on extension of southwest boundary of reserve, 522 feet (159.1 meters) north-northwest of northwest corner, about 300 feet (91 meters) northwest of a clump of trees on some grave-land alongside small rubbish shoot, 14 paces southwest of west corner of low mud bank around field to northeast, 9 paces east of edge of road to west; marked by concrete post, 6 inches (15 cm.) square, and 48 inches (122 cm.) long, its top face left 6 inches (15 cm.) above ground, and with letters C. I. W. molded on one side. True bearings: bottom of high ornamental pole in town, 1.5 miles (2.4 km.), 232° 35'.8; bottom of flagstaff at chief engineer's office, half mile (0.8 km.), 263° 42'.5; top of post near large tank, 273° 49'.7; bottom of chimney at right end of engine shed, 284° 28'.7.

Kuanti, Chihli, 1915.—On premises of inn, near southern corner of larger inner yard used as resting-place for camels, at a point 74 feet (22.6 meters) northwest of southeast wall of mud and rubble-stone, and 61 feet (18.6 meters) northeast of southwest wall; marked by conical hole cut in top face of an irregular stone, sunk nearly flush with ground. True bearing: western edge of chimney on small building of inn, about 100 yards (91 meters), 192° 42'.4.

Kwanchengtze, Kirin, Manchuria, 1916.—In extreme southeast corner of open grassy land in Russian concession lying between southmost Russian buildings and a small stream flowing east, on north bank of stream, 5 paces west of southwest corner of a cultivated field, west side of which forms east boundary of Russian concession, about 50 feet (15 meters) from bottom of stream bed, and 8 paces east of edge of gully; marked by a wooden peg 26 by 2 by 2 inches (66 by 5 by 5 cm.), left just beneath surface of ground. True bearings: top of railway water-tower, 1.5 miles (2.4 km.), 6° 30'.4; bottom of electric-light pole to left of bridge over stream, about 800 feet (0.25 km.), 100° 38'.8; bottom of chimney-stack, one-fourth mile (0.4 km.), 143° 55'.8; right gable end of long shed, about 800 feet (0.25 km.), 185° 12'.3; rightmost ornament on roof of large gray factory, 1.5 miles (2.4 km.), 328° 51'.7; right spike on Chinese ornamental tower, 1.5 miles (2.4 km.), 343° 10'.0; dome of Chinese hotel, 1.5 miles (2.4 km.), 345° 57'.8; center gable of Japanese railway station, 1.5 miles (2.4 km.), 348°55'.6.

Kwangnanfu, Yunnan, 1917.—About half mile (0.8 km.) northwest of west gate of city just west of military parade-ground, which is a level uninclosed strip of grass-land crossed by telegraph-line, on low spur between two rice valleys about equidistant from village of Taipingchai to southwest and a temple to north on low hill above parade-ground, known as "Yang Kwan Miao," about 150 feet (46 meters) south of road from west gate of city, about 100 feet (30 meters) northwest of westmost of two grave-pillars on hillside. True bearings: near gable end of temple in village of Taipingchai, 69° 31'.1; end of ornament at right end of roof of temple on hill, 185° 58'.6; near gable of solitary house on hill, one-third mile (0.5 km.), 304° 38'.5; top of nearer of two grave-pillars on hillside, 313° 21'.6; top of pagoda on range, 4 miles (6 km.), 359° 03'.0.

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Kwangsinfu, Kiangsi, 1917.—On waste grass-land on left bank of Kwangsin River, opposite west end of west suburb of city, about 1,000 feet (0.3 km.) west of Wang Chia Yuan ferry crossing, about an equal distance north of village of Wang Chia Yuan, and 150 paces from line of bushes on north bank of creek to southwest. True bearings: bottom of left side of pagoda around bend in river, 1 mile (1.6 km.), 72° 39′.8; top of pagoda on right bank of river, half mile (0.8 km.), 103° 31′.3; east corner of gray building on bank of river directly opposite, 222° 43′.6; center roof ornament on red temple near ferry, one-fourth mile (0.4 km.), 264° 06′.1; ornament on temple tower up river, half mile (0.8 km.), 284° 17′.6; near end of roof of rest house, 700 feet (213 meters), 356° 42′.5.

Kwangtunghsien, Yunnan, 1917.—On waste bush land north of main road to Yünnanfu, about 450 paces east of east gate of city, on slope of hill about midway between road and southmost tombs, 65 paces north of road, 17 paces east of hedge of field, about 400 feet (122 meters) east of and in line with two roof ornaments on old temple. True bearings: center ornament on small house on opposite hill, one-third mile (0.5 km.), 9° 52′.8; center ornament on temple to south of town, half mile (0.8 km.), 44° 43′.2; center ornament on large tower in city, half mile (0.8 km.), 59° 56′.9; near ornament on old temple, 72° 00′.8; center ornament on temple on plain, half mile (0.8 km.), 296° 06′.2.

Kwangyüan, Szechwan, 1916.—On south brow of hill occupying eastern section within city wall, north of largest temple on hill, Sun Wong Miao, standing midway on southern slope, 33 paces uphill north of northwest corner in line of west wall of back building of temple and 52.5 paces west of east city wall. True bearing: tip of pagoda on top of low mountain, about 3 miles (5 km.), 45° 07′.4.

Kwanhsien, Szechwan, 1916.—On premises of China Inland Mission, in east suburb of city, in back garden, in center of path between two sections of old mud brick wall dividing garden from east to west, at a point in line between the two sections. True bearing: tip of center ornament on ridge of Mun Cheung Kung temple, about 400 yards (0.4 km.), 161° 54′.0.

Kwanyintong, Shensi, 1916.—On south side of road near middle of village, 11 feet (3.4 meters) and 8 feet (2.4 meters) respectively from west and south walls of small wheat field, 65 by 70 feet (20 by 21 meters), which is bounded on three sides by low stone walls and on east by mud wall of main inn.

Kweichowfu, Szechwan, 1916.—On right bank of Yangtze Kiang on alluvial slope opposite south gate of city. The angle at station between tips of towers at southwest and southeast corners of city wall, distant half mile (0.8 km.) across river, is 50° 38′.

Kweihsien, Kwansi, 1917.—On south bank of river opposite southeast quarter of city on north bank, about 1,000 feet (0.3 km.) west of ferry-landing steps on south bank, at extreme west end of a narrow strip of waste grass-land running along top of river bank, 3 paces from fence of vegetable gardens bounding grass-land on west, 2 paces from edge of rice field to south. True bearings: left gable end of small house, 1 mile (1.6 km.), 84° 35′.6; bottom of cliff-like mountain slope, about 12 miles (19 km.), 121° 03′.0; top of tower of school across river, one-fourth mile (0.4 km.), 146° 26′.4; bottom of left edge of large pawnshop, half mile (0.8 km.), 232° 56′.5; center ornament on rear building of Confucian temple, half mile (0.8 km.), 248° 07′.4.

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Kweitsao, Yunnan, 1917.—In southeast corner of grave-land at base of hill about one-fifth mile (0.3 km.) north of village, 44 paces northeast of a tree growing on south side of land, 3 paces north of footpath across east half of grave-land. True bearings: near gable end of tiled house in village, 1,000 feet (0.3 km.), 6° 22′.5; near gable end of temple at west end of village across river, half mile (0.8 km.), 14° 31′.8; bottom of nearby tree on south side of grave-land, 30° 50′.4; near gable end of highest temple building on hill, half mile (0.8 km.), 316° 38′.6; center ornament on temple across river, 358° 42′.3.

Kweihwating, Kweisuitao, 1916.—About 1 mile (1.6 km.) north of west gate of town, about 2 miles (3 km.) northeast of Swedish Mission, and about three-fourths mile (1.2 km.) beyond Mohammedan cemetery on grassy land between Martyrs' graveyard and small river, in line with south wall of graveyard, 102 feet (31.1 meters) and 177 feet (53.9 meters) respectively from southeast and northeast corners of wall. True bearings: bottom of southeast corner of wall of graveyard, 76° 44′; center of bottom of ornament on near gable of pavilion, 96° 25′.2; center of top character in inscription on memorial pillar, 111° 19′.7; northeast corner of brick wall of graveyard, 131° 13′; near ornament on theater of temple, one-fourth mile (0.4 km.), 232° 02′.6; top of pagoda tower in town, 354° 19′.0; rightmost pillar at bottom of west gate building, 356° 33′.9.

Kweiyang, Kweichow, 1915.—At northeast end of execution ground, a strip of flat grass-land lying between the two bridges outside south gate of city, about 200 meters east of south gate, 89 feet (27.1 meters) from northeast end of ground, 101 feet (30.8 meters) from rocky outcrop to southeast, and 12 feet (3.7 meters) from right bank of river. True bearings: top of ornamental tower, 1,000 feet (0.3 km.), 79° 46′.2; top of ornament on tower in city, 85° 34′.8; center ornament on top of Woman's Memorial, 300 feet (0.1 km.), 151° 25′.9; spike on top of ornamental house on bridge, 210° 34′.9; top of rightmost ancestor-tablet of temple, 30 meters, 246° 15′.5.

Laitowpo, Yunnan, 1917.—On waste land at base of hills approaching northeast end of village, about 400 feet (122 meters) west of rear building of large gray inn in northeastern part of village, between two old hedge banks, 7 paces south of that bordering field on north, and 14 paces from a second along vegetable gardens, to south. True bearings: cliff of distant mountain, about 10 miles (16 km.), 54° 22′.9; right gable end of front building of inn, 252° 01′.7; near gable of large house in village, about 800 feet (0.25 km.), 299° 08′.7; near gable end of white-fronted house, 400 feet (122 meters), 329° 39′.0.

Lanchowfu, Kansu, 1916.—Exact reoccupation of station of 1909, in northeast corner of compound of Belgian Catholic Mission, outside east gate of city and south of east suburb-wall, 42.2 feet (12.86 meters) from east wall of compound, 37 feet (11.3 meters) from a small tree to northeast, and 58.2 feet (17.74 meters) from north wall of compound; marked by a 0.5 inch (1 cm.) drill hole in top of granite post 8 by 8 by 30 inches (20 by 20 by 76 cm.) projecting 3 inches (8 cm.) above ground and lettered C. I. 1909. True bearings: leftmost of two pillars on mountain, 2 miles (3 km.), 2° 21′.2; left end of arch over gate, 75 meters, 3° 59′.2.

Laohokow, Hupeh, 1916.—On right bank of Han River, opposite upper portion of city, and about one-fourth mile (0.4 km.) above usual upper limit of boats mooring on right bank, on extensive sandy tract

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Laohokow, Hupeh, 1916—continued.
dotted with tall pampas grass, about 100 yards (91 meters) west of water's edge. True bearings: southern side of small tower on distant low ridge, 133° 07′.0; eastern chimney on roof of China Inland Mission house in city, 323° 41′.3.

Laojentsang, Honan, 1916.—On right bank of Tan River, 3 miles (5 km.) above city of Sichwanting, on extensive sand flat about 0.25 mile (0.4 km.) down stream from usual boat landing. True bearing: peak of gable at east end of small temple building, one-fourth mile (0.4 km.), 91° 11′.6.

Laolung, Kwangtung, 1917.—On hillside on east bank of East River, about one-fourth mile (0.4 km.) north of north water-gate, about 750 feet (229 meters) north of stone bridge over junction of a small stream where it joins main river, about 25 feet (8 meters) above level of path running along river bank, and opposite a point on path 73 paces north of small wayside shrine in clump of trees. True bearings: near gable end of large house across river, about 0.75 mile (1.2 km.), 39° 17′.6; near gable end of large house on low hill, about one-third mile (0.5 km.), 48° 00′.8; near gable end of temple at ferry landing, about 1,200 feet (0.4 km.), 72° 24′.3; top of conical mountain, 7 miles (11 km.), 83° 03′.3; center ornament on large temple up river, 1.5 miles (2.4 km.), 188° 30′.2.

Laoniuwan, Shansi, 1916.—On left bank of Yellow River, about 300 yards (274 meters) up-stream from center of village, on small sandy patch, about 20 feet (6 meters) from water's edge. True bearings: eastern edge of signal-tower, at its base, on summit of hill, about 1 mile (1.6 km.), 326° 16′.8; western edge of promontory below village, at instrument level, about three-fourths mile (1.2 km.), 337° 56′.7.

Lautangfong, Szechwan, 1916.—South of road, on premises of inn, the only building in place, at a point 4 paces south of south side of building projected 26 paces east of southeast corner of inn, and 4.5 paces east of mud and thatch shed.

Leiyang, Hunan, 1915.—On open ground at south end of island in middle of Lei River, about 30 feet (9 meters) from west shore of island; marked by small hardwood peg driven flush with ground. True bearings: center of ornamental ball on middle of roof of custom-house, 400 feet (122 meters), 108° 23′.9; left end of top roof of large gray building, 1,000 feet (305 meters), 130° 07′.2; center ornament on roof of temple in Leiyang, one-third mile (0.5 km.), 140° 35′.1; spike on city-gate building, half mile (0.8 km.), 158° 59′.3; bottom of flagstaff at customs-station, one-third mile (0.5 km.), 358° 46′.1.

Liangchowfu, Kansu, 1916.—Station of 1909 was exactly reoccupied; near southeast corner of flat mud roof of house rented by China Inland Mission, 4.6 feet (1.40 meters) from east wall of roof, 6 feet (1.8 meters) from raised portion of roof directly above main entrance, 20.33 feet (6.20 meters) from nearest corner of roof to west, and 22.75 feet (6.93 meters) from edge of false chimney; marked by a brass peg, 0.5 by 1 by 3 inches (1.3 by 2.5 by 7.6 cm.), left level with surface of roof. True bearings: ornament on yamen building, 65° 16′.9; top of pagoda in northwest part of city, 121° 40′.1; left one of two pagodas in northeast part of city, 219° 53′.3; right one of two pagodas, one-fifth mile (0.3 km.), 232° 24′.2.

Liangchowfu, Kansu, Secondary, 1916.—Near south end of military parade-ground alongside General's yamen, about midway between east and west walls of inclosure, and opposite gate-house of soldiers' barracks, 90 feet (27.4 meters) east of northeast corner of gate-house and 226 feet (68.9 meters) from southeast corner of parade-ground; marked by gray brick 3 by 6 by 12 inches (7.6 by 15.2 by 30.5 cm.) set on end about 2 inches (5 cm.) below surface. True bearings: top of watch-tower of barracks near southwest corner of parade-ground, 300 feet (91 meters), 35° 09′.3; right edge of gate-house, 92° 11′; left gable end of telegraph-office, 600 feet (183 meters), 176° 12′.0; top of center ornament on temple near northeast corner of parade-ground, 196° 32′.4; top of pagoda one-fourth mile (0.4 km.), 212° 37′.9; near gable end of temple, 277° 12′.3; southeast corner of parade-ground, 344° 33′.

Liangkochwang, Chihli, 1915.—North of inns in western portion of village, in northeast angle of intersecting roads, at edge of cultivated plot, on top of steep bank, about 40 feet (12 meters) north and about 30 feet (9 meters) east of two roads respectively. True bearing: vertical axis of top of prominent pagoda on mountain peak, about 3 miles (5 km.), 334° 01′.0.

Liaoyang, Shengking, Manchuria, 1916.—Inside city, in about middle of large vegetable garden of French Catholic Mission girls' orphanage, north of and adjoining compound containing cathedral and priests' residence, over a tree stump on east side of main path of garden, about midway between north and south boundary walls, 210.5 feet (64.16 meters) south of shrine in south wall of memorial houses, and 44.5 feet (13.56 meters) south of center of brick drain crossing path; marked by a cross cut in tree stump, which appears just above surface of path. True bearings: staff on small tower, one-third mile (0.5 km.), 6° 13′.9; top of right chimney of priests' residence, 16° 09′.0; top of cathedral spire, 22° 22′.4; right end of right ornament of laborer's house, 49° 00′.9; top of lama tower, half mile (0.8 km.), 125° 33′.3; northwest corner of garden wall, 172° 28′.5; bottom of left wall of house at north end of path, 190° 33′.7; center right ornament on north gate of city, one-third mile (0.5 km.), 211° 22′.0.

Linanfu, Yunnan, 1917.—About one-fourth mile (0.4 km.) northwest of north gate of city, at west end of suburb running west from east gate, on grass-land 43 paces southeast of southeast corner of most southerly building of Lu Pan Tien (Carpenters' temple), just south of large grave-mound, 2 paces west and 3 paces northeast of edge of surrounding field. True bearings: top of large pagoda, 2 miles (3 km.), 1° 36′.4; top of west corner of city wall, 21° 29′.6; bottom of large grave-pillar, 500 feet (152 meters), 26° 20′.0; near end of south temple building, 142° 36′.0; near ornament on east gate building, 291° 01′.9; right ornament on north gate building, 318° 29′.2; center ornament on large temple in city, 354° 15′.0.

Linki, Chekiang, 1917.—On crest of low steep hills rising from south bank of canal winding around south outskirts of village, about 100 yards (91 meters) southwest along path leaving road at a point about 230 paces south of bridge at east end of Linki, on small piece of waste grass-land just south of path and just beyond west corner of a large garden surrounded by a hedge, 22.5 feet (6.86 meters) southwest of boundary stone at west corner of garden, 29 feet (8.8 meters) and 35 feet (10.7 meters) respectively from boundary stones to northwest and southwest. True bearings: boundary stone north of path, 119° 45′; bottom of

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Linki, Chekiang, 1917—continued.
west side of China Inland Mission chapel, about 1,000 feet (0.3 km.), 139° 53′.9; bottom of east side of chapel, 142° 57′.1; ornament on temple at east end of Linki, about one-fourth kilometer, 170° 51′.2; boundary stone at west corner of garden, 212° 44′; rear end of white-roofed farmhouse, 1 mile (1.6 km.), 292° 56′.2.

Lipohsien, Kwangsi, 1915.—Near middle of inclosed land south of town official's yamen, 49 feet (14.9 meters) south of north wall of inclosure, 102 feet (31.1 meters) southwest of right pillar at small gate-house at north entrance, 320.5 feet (97.69 meters) west of south end of detached wall at east end of grounds; marked by a round hardwood stake, 3 inches (8 cm.) in diameter driven flush with surface of ground. True bearings: center ornament of temple at west end of grounds, 77° 55′.2; center ornament on brick wall of yamen, 112° 18′.3; bottom of left pillar of house over well, 210° 11′.9; right pillar of gate-house, 228° 09′; bottom of right post of city-gate building, 600 feet, (0.2 km.), 263° 15′.9; bottom of right edge of detached wall at east end of grounds, 273° 45′.2.

Litsinghsien, Shantung, 1915.—Outside city, on waste land lying between left bank of Yellow River and cultivated ground, about 1,200 feet (366 meters) south-southwest of east end of main road leading from boat landing to east gate of city, 33 paces west of left bank of river. True bearings: ornament on tower of temple in city, 1 mile (1.6 km.), 95° 44′.1; right gable end of east gate building, 107° 26′.3; east end of main road from landing to city, 202° 25′.0; near gable end of farmhouse, 1.5 miles (2.4 km.), 239° 14′.6; middle of large gravestone across river, 1 mile (1.6 km.), 324° 11′.8.

Liuchauwan, Shensi, 1916.—On right bank of Yellow River, near middle of a great bend in river around wide-spread cone of pebbles and boulders, on firm sandy stretch about 150 feet (46 meters) from water's edge. True bearing: southeastern corner of temple standing on left bank of river, about 1 mile (1.6 km.), 192° 09′.7.

Liuchowfu, Kwangsi, 1915.—At east end of military parade-grounds, about one-fourth mile (0.4 km.) north of north gate of city, in line with east wall of most easterly temple building at north end of parade-ground, 274 feet (83.5 meters) southeast of its southeast corner, 147.2 feet (44.87 meters) from north end of a detached temple wall, and 51 feet (15 meters) west of cart track leading north; marked by round stake about 3 inches (8 cm.) in diameter, driven level with surface of ground. True bearings: near gable end of church, one-fourth mile (0.4 km.), 14° 46′.7; ornament on middle of roof of recreation-house, 67° 11′.4; center ornament on roof of temple, 600 feet (0.2 km.), 137° 05′.4; center ornament on rear building of large temple, 162° 15′.7; southeast corner of most easterly temple building at north end of parade-ground, 172° 17′.0; bottom of north end of detached temple wall, 282° 38′.

Liupating, Shensi, 1916.—South of village suburb east of walled city, on narrow grassy plot of ground on left bank of stream, 3 paces north of north side of path from village leading up to water-wheel mill, measured from a point 40 paces down-stream, along path, from east side of mill and toward high bank marking left side of river valley. True bearing: tip of pagoda, about 1 mile (1.6 km.), 310° 38′.7.

Liushuho, Yunnan, 1917.—In field about 300 feet (91 meters) southeast of southmost house on east side of

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Liushuho, Yunnan, 1917—continued.
main street of village, 26 paces east of solitary fir tree standing on small mound, 5 paces west of east edge of field. True bearings: right edge of trunk of solitary fir tree, 83° 02′.5; center of window in wall of house on hill, 1 mile (1.6 km.), 168° 00′.9; lone pine tree on hillside, 1.5 miles (2.4 km.), 204° 23′.6.

Loh Fau Shan, Kwangtung, 1914.—On summit of College Hill on mountain Loh Fau Shan, about 10 miles (16 km.) slightly east of north from Sheklung, 2.85 meters north of north branch of path to mess-hall measured from a point 14 paces up from junction of two branches, in middle of triangular hollow whose corners are marked by large irregular stones, 1.96 meters, 1.73 meters, and 1.55 meters, from left corner of stones to southwest, north, and east respectively; marked by hardwood tent-peg driven nearly flush with ground and covered by a small pile of stones. True bearings: point of a triangular rock near crest of Pair Hill, 68° 24′.6.

Lokung, Yunnan, 1917.—About one-fourth mile (0.4 km.) west-northwest of northwest end of village, at base of steep limestone cliff on west bank of stream, about 150 feet (46 meters) northwest of small stone bridge across stream, 21 paces west of large rock on which is a stone tablet inscribed with Chinese characters, 5 paces west of footpath leading to bridge.

Loyüanhsien, Fukien, 1917.—Within south corner of large garden south of and adjoining residence-compound of mission station of Church Missionary Society, near east gate of city, 46 feet (14.0 meters) from south corner of garden wall, 52 feet (16 meters) southwest of clump of trees on circular mound in center of garden, and 38 feet (11.6 meters) from west garden wall. True bearings: top of ornamental tower, 150 feet (46 meters), 47° 57′.2; northwest corner of garden wall, 100 feet (30 meters,) 137° 15′; near end of roof ridge of residence, 160 feet (49 meters), 189° 23′.9; center of hole in east wall of garden, 120 feet (37 meters), 216° 10′.2.

Luchow, Szechwan, 1916.—In residence-compound of Canadian Methodist Mission station in San Tao Kuai in northwest corner of city, on grass plot in front of Mr. Jolliffe's residence, in line with outer edge of veranda pillars on southwest side of house, near east corner of tennis-courts, 66 feet (20.1 meters) southeast of veranda pillar in south corner of house, 39 feet (11.9 meters) south of corner of brick wall, 25.3 feet (7.71 meters) southwest of edge of paved path, 52.5 feet (16.00 meters) north of southwest wall bounding garden plot; marked by stone block 8 by 8 by 20 inches (20 by 20 by 51 cm.) with top face inscribed C. I. W. 1916, with a drill hole at center, and set just below ground. True bearings: ornament on roof of temple visible through east veranda pillars of residence, 1.5 miles (2 km.), 160° 40′.3; center ornament on roof of temple on hill, 1.5 miles (2 km.), 172° 34′.2; nearby corner of garden wall, 183° 42′.0; center ornament on roof of Chinese house, 1,000 feet (0.3 km.), 209° 05′.8; right edge of right eaves ornament on roof of residence, 244° 38′.0; ornament on tower of church, 100 feet (30.5 meters), 321° 54′.1.

Lufenghsien, Yunnan, 1917.—Outside city, on knoll of rough waste land, between Tung Yu Miao (temple) and east gate of city, on extreme south end of tract, about 200 feet (61 meters) north of rear of temple, about 400 feet (122 meters) south of east gate of city, about 120 feet (37 meters) east of east wall of city, about 120 feet (37 meters) northeast of mill. True bearings: bottom of northwest corner of temple wall,

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Lufenghsien, Yunnan, 1917—continued. 37° 56′.8; west end of roof of mill, 71° 32′.0; top of ornament on south gate of city, one-fifth mile (0.3 km.), 78° 26′.0; bottom of right corner of east gate, 192° 57′.9; bottom of left wall of mud house on hill, 1 mile (1.6 km.), 230° 21′.6; top of old pagoda, 3 miles (5 km.), 272° 04′.4; top of pagoda on hill, 2 miles (3 km.), 325° 21′.6; northeast corner of wall of temple, 359° 11′.3.

Lukiapang, Kiangsu, 1917.—Observations were made at three points during intercomparisons with standard instruments of Lukiapang observatory, at D_a magnetometer pier in absolute house, at D_b 1 meter north of pier upon which earth inductor is permanently mounted, and at *F*, a tent station about 18 meters southwest of magnetometer pier.

Lunganfu, Szechwan, 1916.—In large south yard of premises of Church Missionary Society, at a point 27 feet (8.2 meters) south of north mud wall and 27 feet (8.2 meters) east of west mud wall of yard.

Lunganhsien, Kwangsi, 1917.—At east end of shelf of grass-land used as burying ground, and known as "No Sang," about one-third mile (0.5 km.) southwest of south gate of city, just east of road from south gate of city where it turns up between hills, about 250 feet (76 meters) east of prominent tree growing near road, about 120 feet (37 meters) south of bushy tree, 10 paces west of east extremity of grave-land. True bearings: bottom of prominent tree near road, 87° 52′; right gable end of front building of temple, one-third (0.5 km.), 175° 21′.1; bottom of nearby bushy tree, 188° 40′; left gable end of south gate of city, 205° 43′.6; left gable of tower in southeast corner of city, 222° 18′.0; center ornament on roof of Confucian temple, half mile (0.8 km.), 244° 03′.3; top of pagoda across river, 2 miles (3 km.), 253° 47′.6; center ornament on rear temple building, 0.75 mile (1.2 km.), 271° 39′.6.

Lungchüchai, Shensi, 1916.—On western slope of hill about 1 mile (1.6 km.) south of city, on right side of main road leading to Kingtzekwan, near northwest corner of uncultivated plot of ground, southwest of main building of temple called "Chin Shan Shih," 35 paces south of southeast corner of small temple building, and 70 paces south-southeast of middle of south wall of theater pavilion. True bearings: southeast corner of temple building on mountainside, 1 mile (1.6 km.), 143° 20′.4; tip of gable ornament on south end of theater pavilion, 172° 06′.6; tip of gable ornament on south end of main building of temple, 220° 15′.1.

Lungwangchan, Shansi, 1916.—On left bank of Yellow River, about half mile (0.8 km.) above upper end of village of Lungwangchan, about 150 yards (137 meters) north of point opposite north end of small settlement, known as "Silungwangchan," on hard sandy stretch of path amid boulders, just south of entrance to tributary ravine, the first north of town. True bearing: vertical axis of small window in north end of stone fortification on left bank of stream, about 1.2 miles (1.9 km.), 354° 11′.2.

Lungyenchow, Fukien, 1917.—Across river southeast of city, southeast of junction of two small streams, 15 paces west of flood bank between river and rice fields to east, about 150 feet (46 meters) west of small mud hut in clump of trees. True bearings: near ornament on south gate of city, 0.5 kilometer, 75° 27′.8; center ornament on roof of Confucian temple, 107° 06′.0; top of tower in northeast corner of city, 125° 50′.2; top of pagoda on west bank of river, 144° 27′.7; center ornament on east gate of city, one-third kilometer,

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Lungyenchow, Fukien, 1917—continued. 163° 59′.1; south end of roof of small mud hut in clump of trees, 279° 31′.0; top of pagoda on mountain, 2.5 kilometers, 323° 04′.1; distant pagoda, 6 kilometers, 345° 25′.6.

Lutungpu, Yunnan, 1917.—In field at east end of flat-topped hill which rises from northeast end of village, on edge of cleared land in southeast corner of field, about 30 paces up bank south of a point in main road 240 paces east of northeast end of village, about 31 paces west of ruined mud house, 36 paces from northeast lower corner of field, 23 paces southeast of prominent tree in field, and 3 paces north of tree stump.

Lwanchow, Chihli, 1916.—In gully about 600 feet (183 meters) south of Ta Chiao Ssu, a temple on hillside about one-fourth mile (0.4 km.) northwest of railway station, on old track leading down from temple to cart road to railway station, 25 paces north of cart road, 4 paces southwest of big boulder in hillside. True bearings: top of pagoda on hill, 3 miles (5 km.), 0° 58′.1; center ornament of temple on hill, near pagoda, 3° 11′.9; ornament on right end of roof of temple on small hill, three-fourths mile (1.2 km.), 12° 23′.2; center hole in left ornament of temple on hill, 182° 16′.4; near gable end of highest roof of iron buildings south of railway, 358° 50′.4.

Macau, 1914—Reoccupation of station of Saderra Mata in 1892, on granite hill back of summer residence of Bishop, near western end of settlement, in middle of ridge just south of path, and about 56 paces north-northwest of northwest corner of wall of Bishop's compound, nearly in line between lighthouse tower and concrete harbor or geodetic mark on hill; marked by an inch (3 cm.) hardwood peg driven flush with ground. True bearings: concrete harbor mark, 29° 03′.6; tip of lighthouse tower, 236° 30′.2.

Manchouli, Heilungkiang, Manchuria, 1916.—On waste open land adjoining south edge of town, about two-thirds mile (1.1 km.) south of railway station, about one-fifth mile (0.3 km.) west of solitary red-roofed house in compound, 399 feet (121.6 meters) northwest of northwest corner of fence inclosing two small houses, 38 paces west of intersection of two cart tracks running northwest and northeast towards town; marked by circular peg 5 by 15 inches (13 by 38 cm.) with cross on top face, left just below ground. True bearings: top of leftmost of two high watch-towers, 1.5 miles (2 km.), 121° 08′.5; rightmost of two gables in roof of jail, two-thirds mile (1.1 km.), 170° 43′.8; top of railway water-tower, 175° 29′.6; top of chimney at electric-light works, 1 mile (1.6 km.), 201° 34′.4; top of cross on church tower, 214° 12′.6; bottom of left edge chimney on red-roofed house, one-fifth mile (0.3 km.), 269° 06′.9; northwest corner of fence around houses, 328° 09′.4.

Matszchi, Shensi, 1915.—About 5 miles (8 km.) south of Kanchüan, 70 yards (64 meters) west of center line of road to Lochwan, about a half mile (0.8 km.) north of village, near southeast corner of a burial ground on which are several large trees, 54 feet (16.5 meters) east of and in projected line of north face of triple stone arch. True bearing: peak of gable end of prominent house in village, 17° 09′.3.

Meitan, Kweichow, 1915.—Outside city wall northeast of city, about midway between wall and river bank, about 60 feet (18 meters) northeast of lone tree, on small prominent bluff, about 400 feet (122 meters) northeast of wall, and 47 feet (14.3 meters) from brink of bluff. True bearings: east corner of city wall at bottom, 600 feet (183 meters), 7° 16′.9; center fork

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Meitan, Kweichow, 1915—continued.
of nearby tree, 60° 31′; top of conical mountain, 4 miles (6 km.), 113° 51′.1; center ornament on gatehouse, 800 feet (244 meters), 117° 15′.4; center ornament on building on bridge, one-fourth mile (0.4 km.), 156° 04′.1.

Mengka, Yunnan, 1917.—Near west corner of open grassy slope adjoining northeast corner of mud wall around village, about 400 paces northeast of small bridge in west corner of open space, 42 paces north of northmost of two large trees growing together, 12 paces from small tree to northwest, 67 paces northeast of westmost of five graves in line, and 39 paces from low bank and hedge to northwest. True bearings: center of trunks of two large trees growing together, 28° 11′; near ornament on white-fronted house in outskirts, one-fourth mile (0.4 km.), 42° 56′.6; top of right edge of westmost of five graves in line, 53° 38′.6; center ornament on large tomb across valley, one-fourth mile (0.4 km.), 161° 48′.7; center ornament on tower in valley, one-half mile (0.8 km.), 352° 38′.8.

Mengmow, Yunnan, 1917.—On grass-land outside southwest corner of city wall, in line with south wall of city and 253 feet (77.1 meters) west of southwest corner, 33 paces northwest of base of large banyan tree, 12 paces west of west edge of tobacco patch, 23 paces east of edge of main road. True bearings: leftmost of two bamboo masts outside west city gate, 1,200 feet (366 meters), 175° 28′.6; center of arch of west gate, 1,200 feet (366 meters), 179° 16′.0; southwest corner of city wall, 258° 39′.8; center fork of banyan tree, 306° 12′.9; bottom of large spreading tree on plain, 1.5 miles (2.4 km.), 351° 16′.6.

Mengpan, Yunnan, 1917.—On small mound-like hill just west of north half of west wall of old Shan monastery, about 800 feet (0.25 km.) southeast of Sawbwa's yamen, 18 paces southeast of tree in trunk of which is a gilt Buddha, 23 paces southwest of northwest corner of mud wall of monastery, 25 paces northwest of near corner of door in gateway, 16 paces north of paved path, 6 paces southeast of circular depression in ground near tree. True bearings: near gable end of white-fronted house, about 400 feet (122 meters), 60° 07′.3; right edge of brick pillar at right end of yamen wall, 120° 54′.2; top of spike on head of gilt Buddha in tree, 150° 38′.7; bottom of rightmost of two grave-pillars, about 1,200 feet (0.4 km.), 191° 23′.9; bottom of solitary straight tree on mountain, 3 miles (5 km.), 230° 48′.1; northwest corner of monastery wall, 242° 48′; south end of ridge over gateway of temple, about 100 feet (30 meters), 318° 09′.4.

Mengtsz, A, Yunnan, 1917.—Approximate reoccupation of station of 1911. On flat portion of hill about one-fourth mile (0.4 km.) west of railway station, and about 800 feet (244 meters) northwest of large walled compound containing a trading store. True bearings: top of pagoda tower in plain, 2 miles (3. km), 54° 32′.1; right gable end of railway-station building, 261° 17′.9; bottom of southwest corner of wall of trading store, 313° 55′.2.

Mengtsz, B, Yunnan, 1917.—In large garden at north end of French hospital compound, which is in foreign concession about 1,000 feet (0.3 km.) northeast of French consulate, 76 feet (23.2 meters) south of north wall of compound, 218 feet (66.4 meters) southeast of northwest corner of wall, 207 feet (63.1 meters) north of northwest veranda pillar of east hospital ward, 251.5 feet (76.66 meters) northeast of northwest wall of west hospital ward; marked by a stone block, 6 by 8 by 15 inches (15 by 20 by 38 cm.), with its top face marked C. I. W. 1917, with a drill hole at center to mark exact point, and left level with surface of ground. True bearings: top of leftmost spike on doctor's house, about 600 feet (183 meters), 41° 46′.1; top of pagoda tower, one-third mile (0.5 kilometer), 52° 32′.8; rightmost spike on Kalo's store, one-third mile (0.5 kilometer), 73° 04′.2; right edge of roof of building in northwest corner of compound, 109° 26′.4; right bottom corner of largest pillar of large railway bridge, 4 miles (6 km.), 217° 26′.1; near end of isolation hut in northeast corner of compound, 253°53′.3; bottom of northwest veranda pillar of eastmost ward, 347° 50′.9.

Menglui, Yunnan, 1917.—About 300 feet (91 meters) west-northwest of north entrance to village, on small piece of open bush land adjoining northeast side of thatched mud building serving as a temple, in line with southeast wall of temple and 51 feet (15.5 meters) northeast of its east corner. True bearings: bottom of east corner of temple, 38° 56′; bottom of largest tree on mountain ridge, half mile (0.8 km.), 336° 32′.5; bottom of spreading tree across valley, half mile (0.8 km.), 353° 28′.3.

Micheh, Shensi, 1915.—In cultivated field, about half mile (0.8 km.) south of southwest corner of city wall, 50 paces south-southeast of southeast corner and in line with eastern side of flat-roofed stone-structure measuring 13 paces by 16 paces with three arches opening to west. True bearing: vertical axis of ornament of near gable end of house just visible to right of east side of stone-structure, 0.3 kilometers, 153° 16′.4.

Mohei, Yunnan, 1917.—On small flat top of scrub-covered hill rising from about center of town, about one-third mile (0.5 km.) west of Salt yamen, about 800 feet (244 meters) south of large horse-inn on main street near west end of town, and about 200 feet (61 meters) north of salt-watching sentries' hut, in small saddle below. Hill slope begins 9 paces to west, 10 paces to north, 11 paces to south, and 7 paces to east. True bearings: near corner of sentries' hut, 12° 02′.0; near gable end of temple in valley, half mile (0.8 km.), 122° 03′.7; near gable end of temple on opposite hill, half mile (0.8 km.), 194° 47′.3; near gable end of residence of Salt yamen, 285° 00′.6; center ornament on temple at south end of town, one-fourth mile (0.4 km.), 339° 22′.0.

Mongkong, Kwangsi, 1917.—On north bank of West River, about one-fourth mile east of town of Mongkong, about 200 paces east of Ling Kwan Ssu temple, which is situated on east bank of Meng River near its junction with West River, and 5 paces south of edge of field. True bearings: near gable of southmost building of water front, one-third mile (0.5 km.), 66° 56′.6; bottom of right edge of pawnshop, one-third mile (0.5 km.), 75° 41′.5; center ornament on roof of temple, 81° 40′.6; bottom of high telegraph-mast, near bank of Meng River, 109° 52′.0; left gable end of temple, about 1,000 feet (0.3 km.), 207° 20′.2; near gable end of large temple building down river, 2 miles (3 km.), 275° 51′.9; center ornament on temple across river, half mile (0.8 km.), 304° 16′.1.

Moukden, Shengking, Manchuria, 1916.—On grounds of Moukden golf links, across South Manchurian railway, about 1 mile (1.6 km.) north of American consulate, at a point just east of low bank forming northwest boundary of grounds and just west of second and fourth putting-greens, about 500 feet (152 meters) northeast of golf-club pavilion, 40.7 feet (12.41

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Moukden, Shengking, Manchuria, 1916—continued. meters) west of a gravestone, 103.7 feet (31.61 meters) north of another gravestone, and 25 feet (7.6 meters) northeast of center of small trench; marked by a granite stone 7.5 by 7.5 by 38 inches (19 by 19 by 97 cm.), with top inscribed C. I. W., 1916, a drill hole indicating exact point, and left just below surface. True bearings: top of golf pavilion, 29° 51′.3; cross on Russian war memorial, 2 miles (3.2 km.) 39° 08′ 4; top of lama tower, 2 miles (3.2 km.), 41° 49′.9; top of pagoda, 2 miles (3.2 km.), 107° 05′.6; center of rightmost scroll on roof of temple at Pei Ling, 2 miles (3.2 km.), 174° 57′.4; top of east lama tower, three-fourths mile (1.2 km.), 245° 44′.0; rightmost of two steeples of Roman Catholic Cathedral, 2 miles (3.2 km.), 333° 52′.1; bottom of flagstaff of American consulate, 1 mile (1.6 km.), 357° 12′.5.

Nanchang, Kiangsi, 1917.—Two stations were occupied. Station *A* is an exact reoccupation of station of 1908 and 1911, on grounds of American Methodist Mission, between three mission residences and river, and west of south residence, 13 paces from river wall measured from point 39 paces northeast of first angle; marked by cross in top of granite slab 3 by 11 inches (8 by 28 cm.), projecting about 7 inches (18 cm.) above ground. True bearings: bottom of high telegraph-mast down river, 0.75 kilometer, 51° 44′.1; left gable end of long red railway-shed across river, 0.75 kilometer, 114° 22′.5; southwest corner of south mission residence, 75 meters, 281° 28′.5.

Station *B* is about one-fifth mile (0.3 km.) southeast of station *A*, south of residence compound of American Methodist Mission, on site of proposed University, south of boys' school compound, on a sandhill in line with east wall of boys' recreation-ground, 210 feet (64 meters) south of southeast corner of wall; marked by granite block 5 by 6 by 15 inches (13 by 15 by 38 cm.) buried about 6 inches (15 cm.) below surface, and covered by a cairn of stones 3 feet (1 meter) high. True bearings: left end of roof of girls' school, 0.25 kilometer, 25° 25′.7; top of figure at near end of roof of boys' school, 150 meters, 128° 02′.0; bottom of right edge of east chimney on residence at mission, 250 meters, 163° 05′.1; southeast corner of wall of boys' school compound, 182° 47′.7; cross on Roman Catholic church in city, 3 kilometers, 336° 52′.4; top of pagoda outside south gate of city, 5 kilometers, 344° 46′.6.

Nanfen, Shengking, Manchuria, 1916.—On waste land on east bank of river, about one-fourth mile (0.4 km.) north of railway station, about 100 feet (30 meters) from river bank and midway between bank and edge of fields, about 400 feet (122 meters) west-northwest of westmost house of Chinese village, 5 paces west of cart track. True bearings: near gable end of thatched house, 1,000 feet (0.3 km.), 40° 43′.1; near gable end of nearest cottage of village, 285° 29′.8; bottom of leftmost chimney pipe on red-roofed house near railway, 327° 20′.5; center wooden upright in northeast wall of Japanese hotel, 344° 56′.7.

Nankow, Chihli, 1915.—Close reoccupation of Fritsche's station. About half mile (0.8 km.) southeast of railway depot, on stony ridge in old stream-bed, about 45 yards (41 meters) south of point where stream-bed is crossed by road to Ming tombs, and 22 yards east of road running southward along edge of ridge. True bearings: tip of railway signal-post seen about 2° to right of ancient defense wall on nearest mountain slope, 149° 12′.8.

Nanning, Kwangsi, 1917.—On east bank of West River, about 900 feet (274 meters) south of Likin station,

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Nanning, Kwangsi, 1917—continued. which is a large white building at south end of the Bund of the foreign concession, just south of Standard Oil Company's residence, beside low mound on remains of old mud wall, 23 paces from end of old wall to southwest, 137 feet (41.8 meters) southwest of large tree growing on wall, 109.5 feet (33.38 meters) west of boundary stone. True bearings: flagpost over large gray building on water front, 2 miles (3 km.), 159° 02′.0; top of leftmost turret of large white building, 1.5 miles (2.4 km.), 162° 53′.7; left turret of red tower of Roman Catholic Cathedral in city, 1 mile (1.6 km.), 167° 08′.4; center of top window of English hospital, half mile (0.8 km.), 172° 13′.3; right gable end of Likin station, 180° 47′ 6.; south corner of old city gate-building, about 500 feet (152 meters), 234° 49′.2; top character on boundary stone, 249° 32′.1.

Nantsuitsa, Shansi, 1916.—On large stony area on left bank of Yellow River at great bend in river, the right bank at that point being a high vertical wall of gray sandstone, on top of which, at lower end of turn, stands a prominent group of small temple buildings, including bell-tower and pagoda. True bearings: axis of tip of pagoda in temple group on cliff, 1 mile (1.6 km.), 96° 53′.7; vertical axis of small prominent rock, shaped like a truncated cone, at mouth of side gorge up-stream, about 1 mile (1.6 km.), 303° 15′.5.

Newchwang, Shengking, Manchuria, 1916.—Exact reoccupation of station of 1907. On garden property of B. C. Carlos, 45 paces from boundary line of property on east, 228 paces south of center of a roadway bounding property on north, 80 paces east and 75 paces north from intersection of south boundary of lot with canal; marked by granite stone with cross cut in top face to mark exact spot. True bearings: cross on steeple of St. Nicholas Church, half mile (0.8 km.), 94° 01′.6; northeast turret on Roman Catholic church, half mile (0.8 km.), 117° 49′.5; lowest visible portion of customs flagpole, half mile (0.8 km.), 125° 55′.7.

Ningpo, Chekiang, 1917.—Close reoccupation of station of 1906, north of foreign concession, at west end of recreation-ground of English Methodist college, 326.4 feet (99.49 meters) northwest of and roughly in line with back gate of college and north goal-post of each pair on main football-field, 32.5 feet (9.91 meters) northeast of east corner and 40.3 feet (12.28 meters) east-northeast of north corner of a brick tomb, 48 feet (14.6 meters) northwest of north goal-post of pair at west end of field, and 12 paces southeast of edge of swamp bordering east bank of river; marked by a stone block 6 by 8 by 20 inches (15 by 20 by 51 cm.), with cross indicating exact center, left just below surface of ground. True bearings: top of steeple of St. Paul's Church, three-fourths mile (1.2 km.), 33° 56′.2; north corner of tomb, 63° 59′.2; top of nearest factory chimney across river, one-third mile (0.5 km.), 160° 48′.9; ball on center gable of Industrial School, one-fifth mile (0.3 km.), 230° 02′.3; ornament at left end of roof of school, about 350 feet (107 meters), 284° 54′.1; ornament at right end of roof of school, 305° 44′.9; cross on Roman Catholic church, one-third mile (0.5 km.), 333° 45′.1.

Ningsiafu, Kansu, 1916.—In northwest quarter of city, on waste soda-land adjoining east side of temple of God of Fire (Ho Shen Miao), about one-fourth mile (0.4 km.) southwest of temple of God of Thunder (Lui Shen Miao), 153 feet (46.6 meters) east of southeast corner and 204 feet (62.2 meters) southeast of northeast corner of wall of Ho Shen Miao; marked by

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Ningsiafu, Kansu, 1916—continued.
rough stone block, 5 by 8 by 10 inches (13 by 20 by 25 cm.), sunk 1 inch (3 cm.) below surface of ground, with small cross cut in top face to mark instrumental center. True bearings: center ornament on temple to left of pagoda, 32° 38′.1; top of town pagoda, 34° 04′.8; right gable end of west gate-building, 1 mile (1.6 km.), 78° 18′.3; bottom of southeast corner of wall of Ho Shen Miao, 87° 38′; top spike on near gable end of Ho Shen Miao, 139° 56′.2; center ornament on Lui Shen Miao, 207° 32′.9; near gable end of main north gate-building, 270° 29′.4; top of ornamental tower, one-third mile (0.5 km.), 325° 44′.3; center ornament on distant large temple, three fourths mile (1.2 km.), 355° 28′.2.

Ningyüanchow, Shengking, Manchuria, 1916.—About 600 feet (183 meters) south of Dragon Temple (Leng Wang Miao), which is about three-fourths mile (1.2 km.) east of east gate of city, near east end of strip of vacant land lying between a large field and west bank of a large sandy river bed, 52 paces west of cart track, where it crosses river bed, 7 paces from bank of field to south, 5 paces south of a footpath along bank of river bed. True bearings: bottom of right edge of big tombstone on opposite bank, 400 feet (122 meters), 220° 29′.4; top of left side of fort on mountain, 3 miles (5 km.), 235° 00′.2; ornament on right gable end of house in trees, 1 mile (1.6 km.), 318° 21′.2; top left edge of large tombstone, half mile (0.8 km.), 329° 15′.0; bottom of right edge of left-most chimney of cottage, half mile (0.8 km.), 359° 53′.1.

Niu Chüeh Chüan, Kweisuitao, 1916.—At north end of strip of waste land, near west end of village, across road from and about 160 feet (49 meters) northeast of first inn on right as village is entered from west, 45 feet (13.7 meters) southeast and 46 feet (14.0 meters) southwest of northwest and northeast corners respectively of low mud wall to north, 27.7 feet (8.44 meters) north of near corner of mud altar in middle of strip of waste land. True bearings: near gable end of gate-house of inn, 26° 00′.3; near gable end of temple in village, half mile (0.8 km.), 80° 13′.5; obo on mountain, 3 miles (5 km.), 124° 16′.0; center of near end of right wall of main temple, three-fourths mile (1.2 km.), 171° 26′.2; right gable end of small detached temple, 172° 41′.4; obo on high mountain, 5 miles (8 km.), 349° 22′.5.

Olang Dill Hottock, Outer Mongolia, 1915.—About half mile (0.8 km.) northeast of well known as Olang Dill Hottock, which is situated about one-fourth mile (0.4 km.) west of main road from North Mongolia to Alashan yamen, at south base of some low reddish hills about 300 feet (91 meters) east of road. True bearing: top of obo on distant hill, 3 miles (5 km.), 334° 37′.8.

Olang Oobos Well, Inner Mongolia, 1915.—On bare ground southeast of Olang Oobos well, which is east of main east branch of ox-cart road from Kalgan to Urga, 159 feet (48.5 meters) southeast of southeast side of well. True bearings: Olang Oobos well, 123° 23′; altar above temple, 1.5 miles (2.4 km.), 159° 26′.0; center ornament on roof of temple, 1.5 miles (2.4 km.), 160° 02′.4.

Olang Sire, Outer Mongolia, 1915.—In dry river bed known as Olang Sire through which runs caravan road from Uliassutai to Paotowchow, 18 paces from east bank of river-bed opposite small ravine in low hills, and 104 paces south of Olang Sire well. True bearing: top of obo on hill, 2 miles (3 km.), 41° 31′.8.

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Omeishan, Szechwan, 1916.—On summit of mountain, at a point about 80 yards (73 meters) south of southwest corner of temple on brink of abyss, known as "The True Hall of the Golden Summit," 8 paces west of brink measured from a point 85 paces along brink from southeastern side of temple, and 25 paces east of a point 14 paces north of northeast corner in line of east side projected of woodshed of an adjacent temple. True bearing: eastern corner of lower temple building on another peak, known as "The Temple of 1,000 Buddhas," about 1 mile (1.6 km.), 27° 32′.4.

Pailin, Fukien, 1917.—Near center of village, about 350 feet (107 meters) southwest of chapel of Church Missionary Society, on waste rocky land on south slope of hill about 150 feet (46 meters) south west of large inn on south side of main street. True bearings: center of circular opening in wall of house, 200 feet (61 meters), 264° 20′.7; left end of roof of large farmhouse, 200 feet (61 meters), 290° 43′.9; west gable end of west farmhouse of group in valley, 344° 31′.9.

Paishuiho, Szechwan, 1916.—South of west end of town, on shoulder of hill which forms promontory between Pai Shui Ho and affluent from west, known as "Small River," east of old temple known as "Cheung Fu Tsz," 52.2 feet (15.91 meters) east of southeast corner of most eastern building of temple, and 29.4 feet (8.96 meters) southeast of center of conical stone grave-mound in line between station and northeast corner of temple building. True bearing: east edge of wall of west building of temple group on summit of hill across river valley, about 1 mile (1.6 km.) 195° 54′.6.

Panshantu, Chihli, 1915.—About 1 mile (1.6 km.) south of village, on elevated ground about 17 meters southeast of road from Kalgan almost directly in front of eastern wall of inn near stream-crossing, about 7 meters southeast of center of potato storage-hole which is nearly in line with inn, and 174 paces northwest of telegraph-line. True bearing: tip of gable at east end of prominent building in village, 148° 59′.4.

Paoking, Hunan, 1915.—On summit of grassy hill, about half mile (0.8 km.) southeast of Wesleyan Mission compound, and adjoining cultivated fields owned by the Che family; marked by small round peg. True bearings: top of spike on pagoda in southeast corner of city, two-thirds mile (1.1 km.), 92° 41′.0; rightmost of three ornaments on roof of temple, 1 mile (1.6 km.), 95° 57′.2; near gable end of main building of temple, half mile (0.8 km.), 112° 17′.3; central ornament of temple with graduate pole, one-fourth mile (0.4 km.), 134° 23′.2; top of ornament on pagoda on hill, half mile (0.8 km.), 190° 47′.2; left ornament of temple on summit of hill, half mile (0.8 km.), 318° 01′.1; left end of saddle of Saddle Hill, 2 miles (3.2 km.), 344° 59′.8; right end of saddle of Saddle Hill, 2 miles (3.2 km.), 345° 57′.8.

Paotehchow, Shansi, 1915.—About 1 mile (1.6 km.) up stream from city of Paotehchow on second level of mud flats above low water, in line between caves in face of opposite cliff below up-stream half of Fuku and small grove of trees on Shansi shore near mouth of first tributary above Paotehchow; marked by conical hole near one corner of triangular boulder set with face about 2 inches (5 cm.) above ground, and covered with small pile of stones. True bearings: west side of prominent house on Shansi shore, at top of stone foundation about one-sixth mile (0.3 km.), 22° 09′.6; tip of small octagonal tower with circular windows, near down-stream end of Fuku, 116° 58′.0; vertical

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Paotehchow, Shansi, 1915—continued.
diameter of prominent signal-tower on end of promontory about half mile (0.8 km.), 236° 02′.4.

Paotingfu, Chihli, 1915.—In compound of American Board Mission, outside of southeast corner of city proper, east of entrance to compound and between path running east to boys' school and northern wall of inclosure, at a point 47 yards (43 meters) east of east side of gate-house, 20 feet (6.1 meters) north of north side of path, and about 100 feet (30.5 meters) south of north wall; marked by clearly cut cross in top of shalestone 3 by 8 by 14 inches (8 by 20 by 36 cm.) above ground, the long side standing approximately east and west. True bearings: left-hand edge of small central chimney on residence, 39° 47′.2; western edge of brick pillar on west side of entrance to church-yard across road, about 150 yards (137 meters,) 123° 49′.7. A meridian stone 5 by 6 by 3 inches (13 by 15 by 8 cm.) above ground was placed near south wall of compound, 157 yards (143.6 meters) south of station, the intersection of clearly cut cross in top being exactly south of instrument center in northern stone.

Paotowchen, Kweisuitao, 1916.—About half mile (0.8 km) west of Swedish Mission station in northwest quarter of city, on open ground known as "West Mound" (Hsi Liang), about 300 feet (91 meters) northwest of brick-kiln in gully, and about 700 feet (213 meters) southwest of fort adjoining west wall of city, 89 feet (27.1 meters) southeast of west city wall. True bearings: bottom of bend in ramparts of wall, 700 feet (213 meters), 23° 36′; bottom of left edge of watch-tower on wall, 800 feet (244 meters) 206° 08′.8; top of lama's grave, 1,000 feet (305 meters), 246° 25′.5; bottom of high flagstaff of fort, 1 mile (1.6 km.), 263° 39′.0; near gable end of double-storied temple, two-thirds mile (1.1 km.), 325° 01′.5; near gable end of small temple outside south wall, 1.5 miles (2.4 km.), 334° 47′.2.

Paotsing, Hunan, 1915.—On southwest outskirts of city, near center of military parade-ground adjacent to buildings, formerly a yamen, but now used as soldiers' barracks, 62 feet (18.9 meters) northwest of northwest corner of yamen, 42 feet (12.8 meters) southeast of northwest mud wall of grounds, 131.5 feet (40.08 meters) northeast of south corner of a brick building at southwest corner of parade-ground. True bearings: central ornamenton top of house, 150 feet (45.7 meters), 29° 51′.7; bottom of south wall of brick building, 131.5 feet (40.08 meters), 53° 12′.0; center ornament of temple on top of hill, 1,000 feet (305 meters), 73° 41′.6; center of near ball of gate, 150 feet (46 meters), 216° 47′.8; right ball on grave on hilltop, 1 mile (1.6 km.), 239° 04′.,8.

Patsebolong, Kweisuitao, 1916.—Near south corner of colony's large inclosed threshing floor, which is about one-fourth mile (0.4 km.) northeast of mission-residence compound, 63.5 feet (19.35 meters) from hedge to southeast, 129 feet (39.3 meters) northeast of east corner of mud house near gate, 105 feet (32.0 meters) from near corner of near side of gate; marked by two gray bricks placed together on end, making a column 5 by 4 by 11.5 inches (13 by 10 by 29 cm.), top face of which is left 1 inch (3 cm.) below surface. True bearings: left upright of mission bell-support, 23° 38′.3; near gable end of mission superintendent's house, 30° 42′.7; top of right edge of fort in west corner of compound, 47° 46′.3; bottom of east corner of mud house near gate, 53° 22′; right edge of mud house, half mile (0.8 km.), 71° 33′.2.

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Patung, Hupeh, 1916.—On right bank of Yangtze Kiang, between town and river, on sand-deposit over outcrop of red shale near mooring-place of houseboats, at a point nearly opposite and about one-fourth mile (0.4 km.) southwest of navigation signal-staff on left bank. True bearings: base of navigation signal-staff on left bank, 194° 34′.8; tip of small white 7-story pagoda on left bank at bend of river below town, called "Kweichow Pagoda," about 1 mile (1.6 km.), 281° 56′.8.

Payenjungko, Kansu, 1916.—Near east corner of city, in open space back of Hsien yamen, 69 feet (21.0 meters) from northeast wall of city, 110 feet (33.5 meters) from east corner of wall, and 72 feet (21.9 meters) to near post of gate to stairway to wall. True bearings: center ornament on roof of temple, 101° 14′.8; left upright of west gate of city, 109° 35′.7; top of pagoda tower, 136° 36′.5; center of bottom of near pillar of gate to tower on wall, 198° 05′.7; right end ornament on roof of tower on east corner of wall, 278° 08′.0.

Pehtaiho, Chihli, 1916.—Three stations, designated as *A*, *B*, and *Rocky Point*, were established. Station *A* is in lower half of large field west of house with square tower belonging to a Danish Countess, northeast of Pehtaiho Hotel at Rocky Point, 291 feet (88.7 meters) northwest of northeast corner and 318.5 feet (97.08 meters) northeast of northwest corner of gray-walled compound, 54 paces east of edge of gully; marked by stone block 18 inches (46 cm.) long, with triangular top face, having side of 10 inches (25 cm.) set just below surface and marked with small cross cut to show exact point. True bearings: northwest corner of gray brick wall, 32° 33′.0; top of red tower of large house at West End, 71° 38′.4; ornament on roof of large gray house, 74° 35′.7; bottom of near staff on house, 500 feet (152 meters), 146° 31′.4; near gable end ornament on Auditorium, one-fourth mile (0.4 km.), 249° 48′.1; bottom of left side of Countess's house, 271° 25′.7; northeast corner of gray brick wall, 333° 33′.7.

Station *B* is 92.8 feet (28.29 meters) southwest of *A* and in line with *A* and top of red tower of large house at West End; marked by wooden peg left level with surface.

The station designated *Rocky Point* is on tennis-courts at west end of main bathing beach at Rocky Point, just below Dr. Nye's house, in southwest corner of east section of tennis-courts, which are divided into two sections by a cement drain covered over with wood, 8.25 feet (2.51 meters) north of inside edge of low wall bounding tennis-courts on south, 8.2 feet (2.50 meters) east of edge of drain, 164.7 feet (50.20 meters) to southeast outer corner of wall of courts; marked by stone block 5 by 6 by 27 inches (13 by 15 by 69 cm.), sunk level with suface of court and a cross cut in top face to mark instrument center. True bearings: bottom of leftmost wooden spike on cottage, 800 feet (244 meters), 88° 43′.1; center gable of Dr. Nye's house, 124° 15′.8; bottom of spike on bungalow, 157° 29′.9; outer southeast corner of tennis-court wall, 259° 13′.2; top of red-roofed tower on monastery, 275° 11′.6; cross on kiosk of Russian monastery, 2 miles (3 km.), 276° 43′.3.

Peking, 1907, Chihli, 1915.—Exact reoccupation of station of 1907 and 1909, in northeast corner of Tartar city, near Laura Temple, within observatory grounds of Russian Ecclesiastical Mission, 33 feet (10.06 meters) west of southwest corner of brick observing-tower which carries sunshine bulb; marked by cross cut in

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Peking, 1907, Chihli, 1915—continued.
top face of stone 4.5 inches (11 cm.) square. True bearing: top of right-hand side of column of gray brick in compound wall, seen across moat, about 300 feet (91 meters), 140° 59′.6.

Peking, 1916, Chihli, 1916.—In public park about one-fourth mile (0.4 km.), northwest of north gate of entrance to Temple of Agriculture inclosure, which is opposite Temple of Heaven and separated from it by main road leading from south gate of Peking to Chien Yang Men (front gate of Tartar city), situated among trees about 600 feet (183 meters) west-northwest of large brick platform which stands at junction of two main roads of park, 153 feet (46.6 meters) north of northmost line of fence-posts marking old road, 37 feet (11.3 meters) from tree to southwest, 30 feet (9.1 meters) from tree-stump to northeast; marked by stone block 6 by 9 by 18 inches (15 by 23 by 46 cm.) lettered C. I. W. with hole at center of letter "I" to mark instrument center, set level with surface of ground. True bearings: top of water-tower, 1 mile (1.6 km.), 74° 57′.1; top of tower of large gray building, three-fourths mile (1.2 km.), 172° 44′.3; leftmost steeple of French Cathedral, 2 miles (3 km.), 217° 30′.0; top of tower in legation quarter of city, 2 miles (3 km.), 220° 40′.8; center of top of rightmost ornament on right gable end of Temple of Agriculture, 1,000 feet (0.3 km.), 341° 01′.0.

Pekow, Chihli, 1915.—Opposite southern part of village, directly across stream-bed from a prominent group of large trees north of horse-watering pond, in cultivated field of first terrace at a point 7 feet (2.1 meters) east of a single pair of small trees on western edge of terrace, and just west of small ditch on upper bank of which is an irregular row of trees. True bearings: tip of gable end of most prominent building on west side of stream-bed, 88° 35′.1; vertical axis of southern corner ornament on top of an outstanding "Spirit Shield," about 400 paces, 139° 37′.8; tip of west gable end of prominent temple on summit of high foot-hill, 330° 57′.3.

Pikow, Kansu, 1916.—South of town on boulder-strewn level floor of valley affluent to valley of main river which flows along east side of town, almost due north of low prominent temple on northwest shoulder of first hill to south, and 13 paces south of path from south entrance to town along a prominent low stone wall and leading generally west up valley, measured at right angles to path at a point 35 paces west of southwest corner of wall.

Pingfan, Kansu, 1916.—Approximate reoccupation of station of 1909. West of main road to Liangchowfu, in large private yard across road to northwest of last inn which is on west side of main road near river and about 200 feet (61 meters) southwest of west gate of city, 53 feet (16.2 meters) from north corner of yard, 98 feet (29.9 meters) northwest of northwest corner of small house in east corner of yard, and 29.5 feet (8.99 meters) from a low wall across the north end of yard. True bearings: near gable end of temple on hill, 2 miles (3 km.), 60° 34′.9; ornament over doorway of house across river, 67° 04′.2; near gable end of house near main road, 600 feet (183 meters), 158° 54′.0; bottom of leftmost wooden pillar of west city-gate building, 276° 47′.4.

Pingka, Yunnan, 1917.—About 200 yards (183 meters) north of north gate of village, on small shelf of grass-land about 150 feet (46 meters) northeast of San Chiao Ssu ("Three Religion Temple"), which is at foot of wooded hills rising behind village, 29 paces from large tree to south, 5 paces from bank to northeast. True bearings: left gable end of farmhouse, three-fourths mile (1.2 km.), 12° 48′.6; center ornament on nearby temple, 39° 23′.9; center ornament on temple across valley, 1 mile (1.6 km.), 122° 30′.7; near ornament on roof ridge of house, one-fifth mile (0.3 km.), 355° 43′.5.

Pingma, Kwangsi, 1917.—On small flat ridge in broken country about one-fifth mile (0.3 km.) north of old north gate of former city of Pingma, just above rice fields outside gate and near junction of two tracks leading to it, about 50 feet (15 meters) west of west track, and about 100 feet (30 meters) northwest of junction. True bearings: center ornament on temple in town, 0° 44′.1; left gable end of north gate building, 17° 20′.6; center ornament on small temple near trees, 59° 51′.8; near gable end of farmhouse, one-fourth mile (0.4 km.), 275° 59′.2; left gable end of roof of large gray house, half mile (0.8 km.), 335° 17′.7.

Pingtinobo, Chihli, 1915.—On southeast side of town, to right of entrance to village street which is continuation of road from Kalgan, in center of deep gully between mud wall of yard around first houses of village and road to Dolon-nor, which runs at right angles to road from Kalgan, at a point about 25 feet (7.6 meters) northeast of center of road from Kalgan and 10 feet (3.0 meters) northwest of center of road to Dolon-nor. True bearing: vertical axis of right-hand one of two conical mountain peaks, 22° 40′.7.

Poklo, Kwangtung, 1917.—On lower slopes of hill east of compound of London Mission station, on right bank of East River about half mile (0.8 km.) east of east gate of city, at a point about 400 feet (122 meters) east-southeast of boys' school building and about 800 feet (244 meters) northeast of missionaries' residences. True bearings: right fork of prominent large lone tree on mountain ridge, about 5 miles (8 km.), 13° 39′.8; bottom of right edge of westmost chimney of residences, 51° 39′.2; top of apex of triangle of trigonometric station on hill in city, 72° 28′ 0; top of near corner of mission fence, 82° 03′.7; near gable end of boys' school, 110° 04′.7.

Port Arthur, Kwantung Leased Territory, Manchuria, 1916.—On military reserve just north of Taisho (New) Park, near base of hill and roughly in line with west side of center avenue of park, 157 feet (47.9 meters) northwest of edge of small bank bounding road on north side of park, over Military Stone No. 98, a granite block standing 2.3 feet (0.70 meter) above ground, with top face, 8 inches (20 cm.) square, having a drill hole 1 inch (3 cm.) in diameter at its center, which marks precise point. True bearings: top of black conical tower in town, 1 mile (1.6 km.), 12° 16′.7; bottom of staff on tower of nearby house, 500 feet (152 meters), 30° 03′.4; top of trigonometrical station on hill, one-fifth mile (0.3 km.), 200° 55′.2; top of Japanese war memorial, 1.5 miles (2.4 km.), 290° 09′.1; bottom of signal-mast at lighthouse, 2 miles (3 km.), 324° 15′.5; top of tower on Governor General's building, 1 mile (1.6 km.), 338° 50′.4.

Poseh, Kwangsi, 1917.—On rough stony land about 350 feet (107 meters) east of a large brick tower called "Pa Kuo Ting," situated on hill about one-fourth mile (0.4 km.) north-northwest of west gate of city, at end of flat land on small spur running eastward from tower, 9 paces south of footpath from east gate of tower, 215.5 feet (65.68 meters) from east corner, and 307 feet (93.6 meters) from north corner of mud wall around tower. True bearings: near

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Poseh, Kwangsi, 1917—continued.
gable end of farmhouse, 1 mile (1.6 km.), 6° 09′.6; top of ornament on tower, 78° 34′.4; bottom of north corner of wall around tower, 95° 24′.; center ornament on east gate of city, half mile (0.8 km.) 273° 21′.4; left end of roof of temple on hill, 1.2 miles (2 km.), 278° 29′.1; center ornament on roof of theater, three-fourths mile (1.2 km.), 293° 32′.2; rear gable of tower over west gate of city, 338° 31′.0.

Puerhtu, Yunnan, 1916.—On south bank of Heng River at extreme east end of village, in small garden between some large blocks of rock on one of which a tree is growing, about midway between main road and bank of river, about 150 feet (46 meters) northeast of tea-house in eastern outskirts of village.

Pulantien, Kwantung Leased Territory, Manchuria, 1916.—About 1 mile (1.6 km.) east of railway station, about midway along north side of triangular piece of grass-land on south bank of a sandy river bed, just east of road from north which joins main road leading east from Pulantien at a point where it enters wooded country, 2 paces from west bank of river bed, 16 paces from edge of grove of bushes to southeast. True bearings: near gable end of rightmost residence on hill, 1.5 miles (2.4 km.), 88° 50′.2; left gable end of solitary white house, half mile (0.8 km.), 93° 26′.7; staff on center gable of railway station, 110° 02′.4; top of railway water-tower, 113° 58′.2; bottom of survey station across river bed, 300 feet (91 meters), 172° 29′.9; top of survey station on distant hill, 3 miles (5 km.), 253° 30′.3.

Samhopa, Kwangtung, 1917.—South of south suburb of city, one-fifth mile (0.3 km.) west of west bank of Han River, on rough bushy grave-land, about 400 feet (122 meters) south of southmost house of suburb, 70 paces west of main road and opposite a point on road 236 paces from south gate of city. True bearings: bottom of cross on character over door of compound on hill, one-fourth mile (0.4 km.), 51° 50′.7; center of top of leftmost roof ornament over gateway, 185° 47′.0; right gable end of temple across river, half mile (0.8 km.), 271° 28′.2; top of pagoda tower on bank of river, 341° 06′.8; top of ornament on pagoda on hill, half mile (0.8 km.), 352° 57′.2.

Santuao, Fukien, 1917.—On customs property on water-front near jetty, on lawn in front of custom-house and roughly in line with its southwest side, within angle formed by two stone drains and 10 paces north-west of vertex, 172 feet (52.4 meters) southeast of southmost drain-pipe along south west side of custom-house, 160 feet (48.8 meters) south of customs flag-staff, 101.3 feet (30.88 meters) northwest of nearest lamp-post at inner end of jetty, and 122.7 feet (37.40 meters) southeast of southwest corner of base of sun-dial in front of custom-house; marked by a granite block, about 6 by 6 by 30 inches (15 by 15 by 76 cm.), with two sides inscribed C. I. W. 1917, projecting about 6 inches (15 cm.) above ground. True bearings: west boundary stone of customs grounds, about 200 feet (61 meters), 94° 32′.4; bottom of west corner of southmost chimney of custom-house, 137° 04′.8; bottom of customs flagpole, 172° 11′.2; bottom of east corner of customs shed, 98 paces, 183° 58′.8; right gable end of upper of two gray houses at base of conical mountain, half mile (0.8 kilometer), 245° 58′.4; lamp-post on inner end of jetty, 314° 48′.9; bottom of tide gage, 1,000 feet (0.3 km.), 357° 10′.7.

Sanyüanhsien, Shensi, 1915.—About half mile (0.8 km.) north of the city, on west side of road from Yaochow, in northern part of an L-shaped burial plot, northeast corner of which is 107 paces west ofwest side of road at a point on road 700 paces from gate at northeast corner of outer wall of city, 15 feet (4.6 meters) south of north side of plot and 18 feet (5.5 meters) west of east side. True bearing: tip of prominent tower on city wall, 53° 17′.9.

Shahokiao, Chihli, 1915.—South of inn near eastern end of town, about 100 yards (91 meters) southeast of back door of inn, about 35 yards (32 meters) south of a stream, and just south of eastern end of row of small trees on edge of meadow bordering stream. True bearing: vertical axis of V cut in prominent mountain, 238° 39′.0.

Shakiao, Yunnan, 1917.—On lower slope of wooded hill used as burying ground, which rises from northwest corner of village, on small open grassy space, 8 paces south of footpath leading to northwest corner of village, near point where it descends to join a lane between high banks, 114 paces northwest along foot-path from its junction with lane, about 100 feet (30 meters) northeast of several large tombs. True bearings: near ornament on west gate of village, about 500 feet (152 meters), 8° 27′.4; near gable end of large house across valley, half mile (0.8 km.), 74° 59′.0; center of prominent tomb on hillside, 1 mile (1.6 km.), 112° 50′.2; center ornament on temple, 1,000 feet (0.3 km.), 304° 44′.3.

Shanchatsz, Szechwan, 1916.—Two stations, designated *A* and *B*, were occupied, on eastern slope of Hsueh Shan Pass, about 2 miles (3 km.) from summit of pass. Station *A* is 45 feet (13.7 meters) east of east wall of hut used as an inn, the only building in the place, measured from a point 10 feet (3.0 meters) south of north wall. Station *B* is 66 feet (20.1 meters) east of Station *A*, in line with Station *A* and vertical edge of small peak on mountain ridge, some miles distant to east.

Shangtsuan, Shensi, 1916.—On road to Lungchüchai, 2 miles (3 km.) south of town of Chingtsun, on pine-covered ridge east of and about 100 feet (30 meters) above level of road, just south of small village, at a point 52 paces south of southern one of two large black stone slabs which, with a number of graves, occupy north end of ridge.

Shanhaikwan, Chihli, 1916.—Approximate reoccupation of station of 1907. Southeast of town, near west corner of old wall of a destroyed village, rectangular in shape, a short distance south of point where railroad breaks through great wall which forms northeast side of rectangle, about in line with southwest wall of old village, on knoll used as burying-ground about 120 feet (37 meters) from northwest wall from which it is separated by two gullies. True bearings: center gable of railway station, 100° 04′.6; left gable end of north gate of city, 115° 11′.9; right ornament on south gate building, 116° 17′.8; tower in southeast corner of city wall, half mile (0.8 km.), 149° 06′.4.

Shanyang Yun, Yunnan, 1917.—In north corner of a field, about 500 feet (152 meters) southwest of southwest end of market booths, southwest of village, 70 paces down a small lane which turns off to southeast from dry stony stream bed about 80 paces southwest of southwest end of market, 6 paces west of cactus hedge, 13 paces from north corner of field, 3 paces east of northeast corner of cess-pit. True bearings: center ornament on roof of rear building of temple on hill, half mile (0.8 km.), 63° 35′.5; center ornament on main temple, about half mile (0.8 km.), 65° 01′.5; left ornament on gate-house at southwest end of vil-

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Shanyang Yun, Yunnan, 1917—continued. lage, one-third mile (0.5 km.), 72° 56′.0; center ornament on temple in village, about one-fourth mile (0.4 km.), 183° 32′.2.

Shaowu, Fukien, 1917.—In east corner of largest of a collection of gardens comprising experimental farm of American Board Mission station in east suburb of city, just east of residence compound of mission, on grass-land bounded by low mud wall on northeast, opposite high mud wall of a private garden across street to north, 65 feet (19.8 meters) west of south corner, and 76.3 feet (23.3 meters) southeast of west corner of wall of private garden, 31.5 feet (9.60 meters) east of tree, and 24 feet (7.3 meters) from top of low mud wall bounding farm on northeast; marked by rough stone block, 7 by 9 by 9 inches (18 by 23 by 23 cm.), with top face marked with cross, and left 2 inches (5 cm.) below surface of ground. True bearings: bottom of left side of tower of boys' school, one-fourth mile (0.4 km.), 65° 30′.9; top of ornamental gate-house in residence compound, about 500 feet (152 meters), 95° 00′.4; east corner of doctor's residence, about 500 feet (152 meters), 126° 48′.1; bottom of west corner of wall of private garden, 147° 09′.6; top of south corner of wall of private garden, 272° 41′.7.

Shasi, Hupeh, 1916.—In yard of residence of outdoor-customs staff, on waterfront east of city, in middle of path leading south from main entrance to tide-waiters' house, 64 paces south of outer edge of lowest step, and 83.8 feet (25.5 meters) north of wall of gray brick bounding yard on river side; marked by tent peg about 1 inch (3 cm.) square, left flush with surface of pathway. The magnetic bearing of the tip of flagpole on bund in front of China Merchants Steamship Company's office, about half mile (0.8 km.), is 121° 06′.

Shawan, Szechwan, 1916.—In open field east of inn Changshun, on high ground nearly on level with tops of houses on street, over center of hitching stone 3 by 12 inches (8 by 30 cm.), projecting about 6 inches (15 cm.) above ground, with a hole about 1.5 inches (4 cm.) in diameter cut through from north to south face, 15 feet (4.6 meters) west of high stone wall facing next terrace of steep hillside rising to east, and 36 feet (11.0 meters) south of low stone wall bounding field on north. True bearings: left edge of stone wall of small hut on hillside, about 500 feet (152 meters), 10° 25′.5; right side of central vertical post in frame structure at level of lower horizontal timber, about 150 feet (46 meters), 25° 18′.0.

Shekki, Kwangtung, 1914.—Outside of east gate of city, on land of Tong Clan, in cultivated section known as Hok Yeung Tien, on a clay-lime threshing floor. True bearing: tip of pagoda on Pagoda Hill, outside west gate of city, 96° 53′.2.

Sheklung, Kwangtung, 1914.—On grounds of American Presbyterian Mission, situated on left bank of river, north of railroad, in yard of school, 4.09 meters south of bamboo fence dividing school-yard from that about residence of Rev. A. J. Fisher, and 7.05 meters west of west side of paved path running approximately from north to south; marked by hardwood peg 5 centimeters in diameter, projecting slightly above ground. True bearing: left side of white brick chimney of house, about one-fourth mile (0.4 km.) 107° 45′.2.

Shenchowfu, Hunan, 1915.—On grounds of Reformed Church in United States Mission station, near southeast corner of boys' school-compound, near east gate of city, 55 feet (16.8 meters) from south wall of compound, 97 feet (29.6 meters) southwest of north-

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Shenchowfu, Hunan, 1915—continued. west corner of gate-house, 116 feet (35.4 meters) southeast of northeast corner of boys' school, nearly in line with west side of doctor's house and 80 feet (24.4 meters) south of its southwest corner; marked by a stone, 8 by 12 by 21 inches (20 by 30 by 53 cm.) set with face slightly below surface of ground and bearing the letters C. I. W. 1915 on top and a hole to mark precise point. True bearings: north end of roof of girls' school, 270 feet (82 meters), 48° 36′.3; northeast corner of boys' school near bottom, 116 feet (35.4 meters), 125° 41′.0; near gable of hospital, 300 feet (91 meters), 149° 27′.6; right edge of doctor's house, 90 feet (27.4 meters), 193° 29′.3; bottom of left side of gate-house, 97 feet (29.6 meters), 225° 26′.6.

Shihmen Hun, Hunan, 1915.—On grassy land at extreme northeast end of low stony island in Ling Kiang River south of town, about 160 feet (49 meters) from point of island to northeast, about 60 feet (18 meters) from bank to northwest and southeast, and about 150 feet (46 meters) from right bank of river. True bearings: center ornament on roof of temple, three-fourths mile (1.2 km.), 67° 16′.6; top of woman's memorial monument, one-third mile (0.5 km.), 97° 29′.3; center ornament on roof of temple on left bank of river, 154° 06′.2; cross on front of Roman Catholic church, 170° 19′.4; top of ornament on roof of hexagonal tower near river, 187° 23′.2; center ornament on roof of house, 500 feet (152 meters), 323° 56′.3.

Shihtsuishan, Kansu, 1916.—On waste land between south end of village and Yellow River, about 900 feet (274 meters) southeast of large Mohammedan mosque at south end of village, in line with northeast side of old mud fort and 129 feet (39.3 meters) southeast of its east corner, 49 paces west of old river bank. True bearings: center ornament of gate-house on main road, 68° 57′.3; east edge of fort, 143° 39′; center ornament on gray-roofed temple in village, one-fourth mile (0.4 km.), 160° 09′.2; ornament on center of roof of large temple, half mile (0.8 km.), 179° 28′.2; ornament on gateway of lamasery across river, half mile (0.8 km.), 220° 17′.7.

Shihtszkou, Shansi, 1916.—About 5 miles (8 km.) down-stream from Paotehchow, on left bank of Yellow River, on small sandy patch at mouth of small gully which descends from high bank on top of which is located a single small group of buildings. True bearing: edge of down-stream side of small stone hut on right bank of stream, about three-fourths mile (1.2 km.), 87° 41′.8.

Shiuchow, Kwangtung, 1915.—Exact reoccupation of station of 1911, though brick marker had been removed by leveling operations, on lawn of Wesleyan Mission on prominent bluff south of city and west of river, in line with west side of two-story residence, and 55 feet 2 inches (16.81 meters) north-northeast of east side of small gate in south wall of grounds; marked by cross cut in top of gray brick set just below ground and covered with sod. True bearings: left edge of left pillar of rest-house on hill, three-fourths mile (1.2 km.), 87° 16′.3; right edge of right pillar of rest-house on hill, three-fourths mile (1.2 km.), 87° 30′.4; southwest corner of two-story residence, 80.6 feet (24.57 meters), 163° 04′.8; southeast corner of two-story residence, 120 feet (36.58 meters), 214° 14′.6.

Shuichingchan, Szechwan, 1916.—In cultivated field in river valley, 78 paces south of road leading from west gate of village, measured from point on road 45 paces west of west gate. True bearing: northwest corner of small shrine on hillside across stream, about one-eighth mile (0.2 km.), 278° 26′.6.

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Shuikowchai, Fukien, 1917.—On waste grass-land just below rocky rapid which is about one-fourth mile (0.4 km.) down river from town, on left bank of river, about 7 paces from bank, almost opposite a temple at foot of hills on right bank. True bearings: bottom of south corner of temple wall on opposite bank, 72° 32′.5; near gable end of temple at south end of town, 101° 08′.5; near gable end of roadside shrine on left bank of river opposite south end of town, 143° 45′.7; bottom of solitary straight tree on hill, 2 miles (3.2 km.), 304° 38′.5.

Shuikow Fu, Fukien, 1917.—On mountainside behind town of Shuikow, about one-fourth mile (0.4 kilometer) up winding road from Roman Catholic Mission Chapel on main street just southeast of launch landing, in southeast corner of a tea plantation occupying eastern slope of gully and 12 paces north of road crossing gully. True bearings: center ornament on temple on west bank of river, one-fourth mile (0.4 km.), 50° 39′.1; near gable end of house northwest of temple, 65° 27′.6; right end of white wall of compound, half mile (0.8 km.), 94° 45′.7; bottom of solitary fir tree on opposite slope of mountain, one-fifth mile (0.3 km.), 359° 05′.9.

Shwangtaitze, Shengking, Manchuria, 1916.—On waste soda land about two-thirds mile (1.1 km.) northwest of railway station, about one-fifth mile (0.3 km.) northwest of north end of small village, and about 150 feet (46 meters) southeast of old mound of rifle range, 33 paces northwest of near corner of old well. True bearings: top of grave-post at southeast end of grave land, about 800 feet (244 meters), 5° 13′; top of signal arm on railway, half mile (0.8 km.), 232° 16′.1; top of chimney on water-tower, half mile (0.8 km.), 265° 32′.1; center ornament on temple to right of bridge, 1 mile (1.6 km.), 321° 51′.8.

Sianfu, Shensi, 1915.—Exact reoccupation of station of 1909, in compound of theological school of Swedish Mission, just outside west gate of city, on school playground, 92.8 feet (28.29 meters) north of northwest corner of schoolhouse, 25 feet (7.6 meters) from mud wall on west side of compound, 40 feet (12.2 meters) from southeast corner of gatekeeper's house, and 36.5 feet (11.1 meters) from entrance at main gate; marked by hole in top of grayish-black stone 4 by 7 by 36 inches (10 by 18 by 91 cm.) set flush with surface of ground and lettered C. I. 1909. True bearing: northeast corner of theological school building, about 1 foot (30 cm.) above ground, 332° 39′.2.

Siang, Kwangsi, 1915.—In garden of town-official's yamen which is on main street of town, 86 feet (26.2 meters) south of north wall of garden and 89 feet (27.1 meters) north of a corner in wall in south side; marked by a round hardwood stake 4.5 inches (11 cm.) in diameter, set even with surface of ground and covered with a small cairn of bricks. True bearings: near gable end of court building, 32° 30′.2; near gable end of near yamen building, 47° 30′.2; center ornament over gate in wall, 90 feet (27.4 meters), 342° 15′.9; south corner of garden wall, 352° 32′.

Siaosinkai, Yunnan, 1917.—About one-fifth mile (0.3 km.) west of west end of village, near northwest side of grassy field, just north of official bungalow for travelers which adjoins Chinese Maritime Customs station, 7 paces southeast of hedge and ditch bounding field, 16 paces south of point where footpath crosses ditch, 59 paces from hedge at north corner of field, and 122 paces northwest of east corner of mud wall around large inn near main road. True bearings: east corner of mud wall around large inn near main road,

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Siaosinkai,, Yunnan, 1917—continued.
308° 37′.1; east gable end of building between inn and main road, 319° 25′.7; hole in customs-compound wall to right of large banyan tree, 500 feet (152 meters), 355° 21′.1.

Siaotao, Fukien, 1917.—Across river from village, on flat grassy land lying within acute angle made by river in changing its course from east to northwest, about one-fourth kilometer southeast of southeast gate at end of main street of village, 100 paces south of line of scrub where it joins river bank, 90 paces from river bank in line with tower on opposite bank, 70 paces north of river bank in line with white compound across river, 45 paces east of scrub, and 24 paces east of east corner of nearest bamboo market booth. True bearings: center ornament on roof of white compound across river, 6° 53′.4; bottom of large solitary tree in rice fields, 42° 27′.9; center ornament on temple near river bank southeast of village, 193° 58′.7; top of ornament on tower on opposite bank, 211° 14′.6; top of right stone graduate-pole of two in front of temple, one-fourth kilometer, 245° 45′.6.

Sihfeng, Kwejchow, 1915.—On crest of small hill southeast of town-official's yamen, about one-fourth distance along hill from its north end, 37 paces from top of slope to northeast; marked by a 3 by 2 inch (7.5 by 5 cm.) wooden stake projecting about 4 inches (10 cm.) above ground and covered by a cairn oi stones. True bearings: center of left doorway of house on hillside, one-fourth mile (0.4 km.), 2° 56′.2; near gable end of white-fronted house in city, 145° 14′.8; left gable end of leftmost school building, 400 feet (122 meters), 202° 48′.0.

Siningfu, Kansu, 1916.—In southwest corner of military parade-ground west of military governor's yamen, nearly in line with memorial arch in street west of grounds, 64 feet (19.5 meters) from tree in front of memorial arch, 68 feet (20.7 meters) from west wall of inclosure, and 132.5 feet (40.39 meters) northeast of near corner of gate near southwest corner of parade-ground True bearings: ornament over gate of parade-ground, 36° 25′.6; top of pagoda on mountain side, 2 miles (3 km.), 187° 35′.2; west gable end of rear barrack building, 214° 40′.8; near gable end of General's pavilion, 316° 42′.3.

Sinminfu, Shengking, Manchuria, 1916.—About 1,000 feet (305 meters) southeast of south wall of compound of Irish Presbyterian Mission, at southeast end of narrow strip of land reserved for Christian graveyard, adjoining Mohammedan graveyard, 53 feet (16.2 meters) from top of bush-lined bank forming east boundary of Christian graveyard, 100.5 feet (30.63 meters) northwest of southeast corner of graveyard, and 90.5 feet (27.58 meters) north of northwest corner of Mohammedan graveyard. True bearings: top of spike on Mohammedan mosque, half mile (0.8 km.), 148° 08′.5; bottom of right edge of rightmost chimney of mission buildings, 159° 24′.7; left gable end of long low building, 1 mile (1.6 km.), 189° 00′.3; southeast corner of Christian graveyard, 309° 30′; northwest corner of Mohammedan graveyard, 347° 04′.

Siongyocheng, Shengking, Manchuria, 1916.—On narrow strip of grass-land between south bank of river and north bank of a field, situated about midway between south gate of walled city and large railway bridge over river, about 60 feet (18 meters) west of east end of narrow strip of land where north bank of field joins river bank and continues along it for some distance, 4 paces from bank of river to north, 6 paces

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Siongyocheng, Shengking, Manchuria, 1916—continued. from bank of field to south. True bearings: center ornament on temple outside south gate of city, half mile (0.8 km.), 92° 37′.4; top of chimney on water-tower at railway station, 1.2 miles (1.9 km.), 215° 48′; left gable end of temple on hill, 6 miles (10 km.), 228° 29′.8; top of pagoda on cliff, 3 miles (5 km.), 233° 18′.1; top of chimney stack at pumping station, half mile (0.8 km.), 257° 34′.9; bottom of first telegraph-pole to south of bridge, half mile (0.8 km.), 302° 37′.5.

Siukiu, Fukien, 1917.—On left bank of river, just below east end of village of Siukiu, about 150 feet (46 meters) south of and roughly in line with east side of eastmost house, about 60 feet (18 meters) northwest of small stone boat landing, and 17 paces west of footpath from village to landing. True bearings: near gable end of leftmost visible house, about 200 feet (61 meters), 182° 18′.2.

Sochow, Shansi, 1915.—On top of south wall of city, on first buttress 250 yards (228.6 meters) east of south gate, near middle of grassy plot measuring about 20 paces by 12 paces, 36.1 feet (11.00 meters) east of outer edge of top row of bricks on western edge of buttress, and 18.6 feet (5.67 meters) north of outer edge of top row of bricks on southern edge; marked by conical hole in center of top of gray brick 3.5 by 7 by 14 inches (9 by 18 by 36 cm.), sunk on end so that top is flush with ground. True bearings: center ornament on ridge of temple roof in northeast quarter of city, 199° 12′.0; tip of small tower on east wall, 244° 27′.2.

Sokhontay-in Gol, Inner Mongolia, 1916.—East of caravan road from Urga to Alashan yamen, about 200 paces south of place where it crosses Sokhontay River, 80 paces east of east bank of river, and 9 paces from foot of a series of sand hummocks. True bearings: center of trunk of tree, 1,000 feet (305 meters), 5° 39′; square obo at east end of low range of hills west of river, one-third mile (0.5 km.), 64° 46′.6; obo at west or right end of range of hills, 72° 30′.4; most westerly obo on crest of range east of caravan road, half mile (0.8 km.), 352° 57′.5.

Soolt Shunt Well, Outer Mongolia, 1915.—About 78 paces northeast of main ox-cart road from Kalgan to Urga, 13 paces southwest of small cart track which branches off the main road toward the north from crossing of dry river bed, about 300 feet (91 meters) northwest of Soolt Shunt well, which is merely a small soak-hole about 150 feet (46 meters) north of road west of dry river-bed.

Soom-in Bollock Camp, Inner Mongolia, 1915.—About 42 paces northeast of main east branch of ox-cart road from Kalgan to Urga, and about 100 paces north-northwest of Soom-in Bollock camping place, which is a small area on each side of road used by caravans and marked by holes dug in sand for soakage of water.

Suchow-An, Anhwei, 1915.—In open space east of and adjoining town-official's yamen, 84 feet (25.6 meters) east of east wall of yamen enclosure, 125.5 feet (38.25 meters) southeast of corner of east wall of yamen and north wall of city, 55 feet (16.8 meters) north-northwest of corner of small mud house near west end of bridge over pond. True bearings: fork in tail of ornamental fish at right end of yamen building, 41° 02′.1; near gable end of barracks, 116° 55′.6; center ornament on roof of temple, 600 feet (183 meters), 259° 39′.1; front spike on roof of north gate of city, 1,000 feet (305 meters), 261° 55′.4; near gable end of white fronted house, 900 feet (274 meters), 278° 46′.5.

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Suifu, Szechwan, 1916.—On south bank of Yangtze River opposite city, in extreme east corner of recreation-field just back of Munroe Academy of American Baptist Mission adjoining Dr. Rudd's residence, 4 paces west and 3 paces north of bottom of bank bounding field, 157.5 feet (48.01 meters) from east corner and 248 feet (75.6 meters) from south corner of wall around academy, and 87 feet (26.5 meters) to nearest goal-post; marked by stone block, 8 by 8 by 24 inches (20 by 20 by 61 cm.), with top face left flush with surface of ground, and inscribed C. I. W. 1916, with a drill-hole marking exact center. True bearings: left gable end of Chinese house, 1,000 feet (0.3 km.), 68° 21′.8; left edge of leftmost chimney of Dr. Rudd's house, 800 feet (244 meters), 95° 28′.6; cross on Roman Catholic church, 1 mile (1.6 km.), 96° 40′.9; south corner of wall around school, 101° 59′.7; center ornament on south gate of city, one-third mile (0.5 km.), 109° 10′.2; center ornament on roof of Drum Tower in city, half mile (0.8 km.), 115° 20′.2; top of left edge of ridge of roof of academy, 300 feet (91.4 meters), 128° 31′.4; east corner of wall of academy-compound, 153° 38′.2; center ornament on southeast gate of city, half mile (0.8 km.), 167° 42′.4.

Suitehchow, Shensi, 1915.—On hillside south of ruins of first temple south of road toward Yenanfu, about 1 mile (1.6 km.) west of west gate of city, in line with east wall and 50 paces south of southeast corner of temple. Azimuth observations were made at a point on hill about 200 yards (183 meters) southeast in line with station and east side of stone-arch portal to burial-ground across valley, about three-fourths mile (1.2 km.), whose true bearing is 152° 26′.8.

Sünchow, Kwangsi, 1917.—In east corner of military parade-ground, which is a large uninclosed tract of grass-land about one-fourth mile (0.4 km.) north of west gate of city, 18 paces from nearest point of hedge along northeast side of ground, 30 paces from south-east end of hedge, 47 paces south of small gate in hedge, 3 paces from small footpath to northeast, 65 paces northeast of small stone tower at base of flag-staff, 61 paces north of north corner of stone staircase of pavilion. True bearings: bottom of flagstaff, 33° 32′.4; left gable end of official's private residence, half mile (0.8 km.), 87° 44′.8; bottom of right edge of largest building in fort on hill, 2 miles (3 km.), 126° 27′.6; bottom of telegraph-pole at north end of ground, 600 feet (183 meters), 131° 06′.1; near gable end of small gate in hedge, 167° 18′.5.

Sungki, Szechwan, 1916.—On right bank of river, about 1,000 feet (0.3 km.) below ferry from town of Sungki, about opposite temple on bluff on left bank, 5 paces northwest of bank of small field which lies between thick clump of bamboos and river.

Sungpan, Szechwan, 1916.—In yard of inn which stands in inclosure of south gate, at a point 27 feet (8.2 meters) west of southwest corner of inn, measured on line with south wall. True bearing: edge of dark brick at instrument height in southeast corner of mud-brick wall inclosing inn, about 200 feet (61 meters), 295° 49′.0.

Sungtao, Kweichow, 1915.—Outside the city between northeast city-wall and river, about 300 feet (91 meters) east of north gate, 48 paces southeast of south corner of hedge near temple, and 32 paces south-west of hedge bounding small field by river bank. True bearings: top of center ornament over north gate of city, 84° 07′.5; center ornament on nearby temple, 98° 05′.0; top of pagoda across river, 194° 43′.4; center ornament on temple, 800 feet (244 meters), 318° 40′.3; ornament on temple near wall within city, 450 feet (137 meters), 359° 40′.3.

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Swatow, Kwangtung, 1917.—Close reoccupation of station of 1906, near water-front on north bank of river, in compound of English Presbyterian Mission, on grass-land, almost opposite front porch of middle one of three mission residences in line, facing water-front, 72 feet (21.9 meters) southeast of center of path in front of residences, 50 feet (15.2 meters) west of drain, and 119.5 feet (36.42 meters) southeast of southwest corner of middle residence; marked by a circular block of granite, 8 inches (20 cm.) in diameter and 27 inches (69 cm.) long, with the top inscribed C. I. W. 1917, a drill-hole indicating exact point, and left 10 inches (25 cm.) above surface of ground. True bearings: near end of curve of roof of large building, half mile (0.8 kilometer), 56° 02′.2; near gable end of roof of detached mission residence, about 150 feet (46 meters), 88° 28′.9; southeast corner of east chimney of Dr. Gibson's house, about 120 feet (37 meters), 135° 17′.9; bottom of west side of porch of middle house of three, 164° 01′.3.

Szefangching, Yunnan, 1917.—On rough grass-land, about midway between rice fields and footpath skirting wooded hills to north, about 800 feet (244 meters) west of Shan Temple, which stands on slope at southwest end of village, 14 paces from bank of rice fields to southwest, 18 paces from uppermost foot-path to north. True bearings: bottom of large tree across plain, half mile (0.8 kilometer), 5° 03′.1; top of tall peak of range, 7 miles (11 km.), 90° 54′.6; south corner of old temple wall, 296° 18′.3.

Szemao, Yunnan, 1917.—In southwest end of Customs Gardens, a large mud-walled inclosure just beyond south suburb of city, 57 feet (17.4 meters) from south wall of inclosure, 50 feet (15.2 meters) northeast of eastmost of two trees growing along west half of south wall, 143 feet (43.6 meters) east of southwest corner of wall; marked by a stone block 7 by 5 by 14 inches (18 by 13 by 36 cm.), its top face left level with surface of ground and marked with a cross to indicate exact point. True bearings: near end of roof ridge of temple, 200 feet (61 meters), 121° 16′.6; top of ornament on pagoda tower in city, three-fourths mile (1.2 km.), 214° 06′.4; left ornament on roof of gate building in city, three-fourths mile (1.2 km.), 216° 16′.0; center ornament on roof of temple, about 600 feet (183 meters), 237° 51′.2; center ornament on roof of gate-house, about 400 feet (122 meters), 268° 39′.9.

Szenan, Kweichow, 1915.—Near middle of inclosed recreation-grounds beside residences of town officials, 90 feet (27.4 meters) from east wall of inclosure, 92.5 feet (28.19 meters) northwest of northeast corner of wooden building near southeast corner of grounds, and 129 feet (39.3 meters) from southwest corner of inclosure. True bearings: southwest corner of inclosure, 16° 26′.7; center ornament on roof of temple on hill, one-fourth mile (0.4 km.), 121° 22′.5; near gable end of house opposite northwest corner of wall, 40 meters, 138° 22′.7; top of panel in wall of house, 400 feet (122 meters), 179° 41′.6; bottom of leftmost pile under northeast corner of wooden building in grounds, 92.5 feet (28.19 meters), 298° 37′.7.

Szepingkai, Shengking, Manchuria, 1916.—On strip of waste land between main road and small river, about half mile (0.8 km.) northeast of central circle of township, at southwest end of strip of ground, northeast of and just beyond end of a surveyed road leading northeast from central circle, at a point about 1,000 feet (one-third km.) southwest of river, about 150 feet (46 meters) east of main road, 53 paces south of west edge of mud ruins, 9 paces northeast of cart track

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Szepingkai, Shengking, Manchuria, 1916—continued. and 15 paces from trench along edge of field to northwest. True bearings: spike on right gable end of long building, 1 mile (1.6 km.), 0° 08′.2; spike on right gable end of electric-light works, three-fourths mile (1.2 km.), 12° 36′.3; large lone tree in field, about one-third mile (0.5 km.), 61° 22′; spike on right end of long railway-shed, one-third mile (0.5 km.), 320° 11′.2; spike on roof of large brick house at railway, half mile (0.8 km.), 342° 15′.9; top of water-tower at railway station, 355° 07′.7.

Tabo Ol, Chihli, 1915.—In line with northeast side of low wall around Mr. Larsen's house, which is situated on hill opposite two Mongol encampments of Tabo Ol, 220 feet (67.1 meters) southeast of east corner of inclosure wall, 149 feet (45.4 meters) east of near stone pillar of horse lines; marked by a pyramidal-shaped stone 10 by 10 by 6 inches (25 by 25 by 15 cm.), apex of which is left just below ground. True bearings: right end of top of stone pillar of horse lines, 92° 18′.6; south corner of inclosure wall, 102° 05′; center of chimney at left end of house, 111° 41′.3; bottom of pole in north corner of yard, 126° 12′.2; east corner of inclosure wall, 127° 26′.

Tahuan, Yunnan, 1917.—On grassy slope on east bank of Mekong River, just opposite ferryman's house on west bank, about 60 feet (18 meters) up bank from high-water mark, about 10 paces west of edge of small level shelf used as a field, about 40 feet (12 meters) east of two large trees growing together. True bearings: near gable end of house on opposite bank, 500 feet (152 meters), 39° 37′.8; bottom of straight pine tree on mountain top, 1 mile (1.6 km.), 356° 38′.2.

Taianyi, Shensi, 1916.—On shingle-strewn dry bed of stream on right bank of low-water river, about 500 yards (0.5 kilometer) southwest of small single bridge near middle of more eastern section of village. True bearings: top of telegraph-pole visible through gap between two village settlements, about 1 mile (1.6 km.), 144° 27′.0; outer edge, just under eaves bracket, of southwest corner of temple at east end of village, 259° 42′.0.

Taipingpu, Yunnan, 1917.—In about middle of small field which stretches up steep hillside just north of first inn on right as village is entered from east, about 120 feet (37 meters) north of inn, 7 paces west of small tree, 3 paces northwest of bush northwest of a tall fir tree. True bearings: right gable end of westmost house in village, about 250 feet (76 meters), 31° 26′.1; fork of nearby tree, 254° 16′.8; center of tombstone on hill across valley, half mile (0.8 km.), 351° 37′.2; loophole in wall of house on hillside, one-fifth mile (0.3 km.), 354° 26′.2.

Takwan, Yunnan, 1916.—On small shelf in steep hillside, about 150 feet (46 meters) northeast of north wall and approximately in line with east wall of small temple which forms north end of outskirts of Takwan, about 60 feet (18 meters) northeast of main road from Suifu, and 5 paces northwest of large rock. Magnetic bearings: east corner of temple wall, 33° 23′; top of pagoda tower across valley, half mile (0.8 km.), 139° 46′; top of pagoda on hill one-fifth mile (0.3 km.), 288° 59′.

Talifu, A, Yunnan, 1917.—In southwest corner of foreign graveyard; a small grassy plot inclosed by walls of loose granite rock, property of China Inland Mission, about 500 feet (152 meters) southwest of west end of Wu Li Chiao Tsun (Five Mile Bridge), a village situated on west side of main road from Talifu to Siakwan,

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Talifu, A, Yunnan, 1917—continued.
about 2 miles (3 km.) from north gate of Talifu, 7.7 feet (2.35 meters) north of south wall of graveyard, 19.5 feet (5.94 meters) from southwest corner of graveyard, 8.2 feet (2.50 meters) east of southeast corner of Mrs. Clark's grave, 17.8 feet (5.43 meters) south of northeast corner of child's grave; marked by granite block about 8 by 8 by 20 inchess (20 by 20 by 51 cm.) with top face left level with surface of ground and inscribed C. I. W. 1917, a drill-hole at center indicating exact point. True bearings: top of pagoda appearing over hill, 1 mile (1.6 km.), 149° 20′.2; rightmost of two prominent grave-pillars, half mile (0.8 km.), 153° 08′.5; near gable of gate-house on main road, three-fourths mile (1.2 km.), 183° 50′.9; top of north ornament on temple in village, 1.5 miles (2 km.), 194° 19′.4; top of pagoda on hill across lake, 7 miles (11 km.), 228° 36′.5; top of pagoda at Chaochow, 12 miles (19 km.), 304° 14′.3; top of grave-pillar on hill, half mile (0.8 km.), 342° 11′.7.

Talifu, B, Yunnan, 1917.—In northeast corner of military parade-ground, a large grassy inclosed tract in front of general's yamen, just inside south gate of city, in line with northwest face of and 159.2 feet (48.52 meters) east of west corner of northmost of two gate-pillars in east wall of inclosure, 101 feet (30.8 meters) from north wall and 181.5 feet (55.32 meters) southwest of northeast corner of inclosure. True bearings: near ornament on roof of south gate of city, one-third mile (0.5 km.), 37° 47′.0; top of pagoda, three-fourths mile (1.2 km.), 55° 35′.3; near roof ornament on gate tower in main street, one-fourth mile (0.4 km.), 78° 10′.9; top of pagoda, 1.2 miles (2 km.), 126° 48′.4; top of near roof ornament on temple, 600 feet (183 meters), 196° 24′.4; northeast corner of wall around parade-ground, 214° 29′.2; top of pagoda on hill across lake, 6 miles (10 km.), 241° 32′.4; cross on west face of northmost of two gate-pillars, 245° 56′.5.

Tangshan, Chihli, 1915.—In grounds of Tangshan Engineering College, north of railway and west of depot, in middle of straight running-track extending south from steps of Central Hall between football-field and tennis-courts, at a point 115.7 feet (35.26 meters) north of south wall of college compound, 518.7 feet (158.10 meters) east of west wall, and 10.5 feet (3.20 meters) west of east edge of track; marked by light cross cut in top of stone 11 by 11 inches (28 by 28 cm.) sunk 5 inches (13 cm.) below surface of ground, set with its diagonals approximately north-south and east-west, intersection of cross being 6.7 inches (17 cm.) from north corner and 9.2 inches (23 cm.) from south corner. True bearings: eastern edge of base of triple column at east side of entrance to Central Hall, 178° 09′.4; outer edge of stone ledge at southeast corner of East Hall at level of sills of first-floor windows, 222° 54′.3.

Tantow Yun, Yunnan, 1916.—On shoulder of hill overlooking junction of Heng River and tributary which flows into it at south end of village, about one-fifth mile (0.3 km.) south of temple on hillside, about 300 feet (91 meters) up-hill and south of thatched-roof farmhouse near two large trees, and about in line with temple on hillside, 12 paces east of path passing below magnetic station, 6 paces northwest of mountain track to east. Magnetic bearings: top of memorial arch across small river, 600 feet (183 meters) 77° 30′.2; top of wooden upright in white front of house, 600 feet (183 meters), 167° 38′.9; bottom of center ornament on roof of temple on hillside, 188° 34′.0; center of window in front of house, half mile (0.8 km.), 220° 22′.0.

Tao Ssu Ho, Kweisuitao, 1916.—On waste stony land on north side of village, 66.5 feet (20.27 meters) north of north wall of large field adjoining Roman Catholic Mission compound on east, 96.5 feet (29.41 meters) north, 87° 33′ west of northeast corner of north wall of field, 244 feet (74.4 meters) north 51° 40′ east of northwest corner of mission-compound wall. True bearing: right end of roof of mission house, about 600 feet (183 meters), 15° 43′.3.

Tarn-in Sire, Outer Mongolia, 1915.—About 4 miles (6 km.) north of north end of pass through two high ranges of mountains known as Hoyer Bogdo, on open plain on west bank of dry bed of river running northward from pass.

Ta Tit Tsuen, Kwangsi, 1915.—On small bluff near village wells, about 600 feet (183 meters) northeast of village near main Lipohsien-Kingyuan Road, 74 feet (22.6 meters) from east edge of washing well, 67 feet (20.4 meters) south of near edge of clump of bamboos; marked by rough stone pyramid 3 by 4 by 8 inches (8 by 10 by 20 cm.), the apex of which marks instrumental center, sunk just below ground, four 2-foot (0.6 meter) trenches being dug in form of a cross to help in relocation of pyramid. True bearings: right gable end of house in village, 60° 47′.5; top of left side of isolated peak, 1 mile (1.6 km.), 150° 20′.3; near gable end of detached farmhouse, half mile (0.8 km.), 255° 54′.8; near gable end of farmhouse, 1,000 feet (0.3 km.), 319° 06′.6.

Tatungfu, Shansi, 1916.—About 3 miles (5 km.) northwest of Swedish Mission station, in southeast corner of grave-land just north of Martyrs' graveyard, 64.5 feet (19.66 meters) northwest of northeast corner and 56 feet (17.1 meters) northeast of northwest corner of graveyard wall, 5 paces from east and south sides respectively of grave-land. True bearings: bottom of northwest corner of graveyard wall, 23° 01′; near gable end of temple on fort at village, half mile (0.8 km.), 268° 29′.4; rightmost chimney on railway station, 3 miles (5 km.), 270° 25′.1; center of left ornament on large Buddhist temple, 3 miles (5 km.), 316° 18′.4; top of left scroll on memorial arch, one-fourth mile (0.4 km.), 323° 13′.9; bottom of northeast corner of graveyard wall, 332° 19′.

Tatzekow, Hupeh, 1916.—Two stations *A* and *B* were occupied. Station *A* is on left bank of Han River, about 1 mile (1.6 km.) up-stream from village of Tatzekow, in cultivated field at a point about 25 yards (23 meters) east of upper edge of high river bank. True bearing: tip of gable ornament on white temple building among trees, about 1.2 miles (2 km.), 241° 39′.6;

Station *B* is 10 feet (3.0 meters) south of *A*.

Tayik Hyhun, Outer Mongolia, 1915.—About 3 miles (5 km.) northwest of Buyin Chub well, just west of main road from north Mongolia to Alashan yamen, about 600 feet (183 meters) west of east end of low rocky range known as Tayik Hyhun at base of its south slope. True bearing: top of conical mountain near end of distant range, 20 miles (32 km.), 261° 53′.5.

Tchagan Toonke Hottock, Inner Mongolia, 1916.—East of main caravan road from Urga to Alashan yamen, about 2 miles (3 km.) south of Shartzan Soom (Temple), 168 feet (51.2 meters) east of east edge of well known as Tchagan Toonke Hottock or "White Water-Cask Well," and 129 feet (39.3 meters) west-northwest of tree near dry bed of river. True bearings: gilt ornament on main Tibetan temple, 2 miles (3 km.), 146° 36′.3; obo on ridge to right of temple, 3 miles (5 km.), 157° 02′.3; center fork of tree, 129 feet (39.3 meters), 293° 54′.

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Tehchow, Shantung, 1915.—Outside city in compound of American Board Mission station, in about middle of athletic field at north end of Porter Academy inclosure, 237 feet (72.2 meters) southwest of northeast corner of compound-wall, 145 feet (44.2 meters) west of near corner in east wall of compound; marked by stone block, 5 by 5 by 23 inches (13 by 13 by 58 cm.), top face lettered C. I. W., left just beneath surface of ground. True bearings: top of near chimney of assembly hall 9° 42′.3; near gable end of dormitory 20° 40′.7; near gable end of main building of doctor's house, 1,000 feet (305 meters), 28° 35′.2; top of right chimney of residence, 41° 53′.3; top of nearest right gable end of hospital, 75° 50′.0; top of pagoda in northeast corner of city wall, three-fourths mile (1.2 km.), 101° 43′.2; top of northeast corner of compound wall, 222° 56′.8; top of near corner in east wall, 266° 17′.0.

Tengyueh, Yunnan, 1917.—Outside east gate of city in east corner of large white-walled compound containing residence of chief assistant of Chinese Maritime Customs, just north of commissioner's compound and near British consulate, on large grass plot at lower end of compound below residence, 55 feet (16.8 meters) from northeast wall of compound, 97 feet (29.6 meters) from east corner of wall, 79 feet (24.1 meters) from southeast wall, 10 paces from top of grassy bank to east, 31 paces from bottom of grassy bank to west; marked by stone block 9 by 9 by 18 inches (23 by 23 by 46 cm.), with top inscribed C. I. W. 1917, with a drill-hole at center to mark exact point and left level with surface of ground. True bearings: tip of near ornament on roof of commissioner's residence, 1,000 feet (0.3 km.), 42° 39′.1; top of pagoda on hill, 1.5 miles (2 km.), 69° 42′.1; top of ornament at left end of assistant's residence, 103° 16′.8; center ornament of rear temple of monastery, 2 miles (3 km.), 255° 46′.6; bottom of east corner of compound wall, 260° 43′.3; bottom of south corner of compound wall, 358° 13′.1.

Tiehling, Shengking, Manchuria, 1916.—On west bank of sandy river bed at east end of town, about half mile (0.8 km.) south of railway bridge, about 400 feet (122 meters) northeast of a small gray house owned by a market gardener, about 100 feet (30.5 meters) northwest of north end of a line of trees stretching along bank of river, 8 paces to footpath skirting field to west, and 2 paces from river bank. True bearings: center gable of gray house, 40° 31′.1; top of round tower in town, 1.5 miles (2.4 km.), 50° 02′.7; top of pagoda, 1 mile (1.6 km.), 65° 24′.6; bottom of tall chimney at west end of railway bridge, 138° 57′.6; telegraph-pole at east end of railway bridge, 163 °21′.3; bottom of ornament of pagoda on hill, 2 miles (3.2 km.), 359° 45′.5.

Tienchen, Shansi, 1916.—On vacant land about one-fourth mile (0.4 km.) northwest of north gate of city, 7 paces north of bank forming north boundary of fields, 8 paces south of center of road to north gate of city. True bearings: top of northwest corner of city wall, about 1,200 feet (0.4 km.), 46° 23′.4; center of right chimney of railway station, 2 miles (3 km.), 145° 42′.7; top of signal post on railway, 2 miles (3 km.), 152° 01′.5; top of left pillar of monumental grave, half mile (0.8 km.), 170° 16′.4; center ornament on temple across river, half mile (0.8 km.), 201° 29′.6; top of northeast corner of city wall, three-fourths mile (1.2 km.), 288° 06′.8.

Tientsin, Chihli, 1916.—Inside course of Tientsin Race Club grounds near beginning of turn at northeast corner, about 250 feet (76 meters) north of northeast corner of polo-ground lying inside course, and about 400 feet (122 meters) south-southwest of pole marking northeast corner of outside racing track, 121 feet (36.9 meters) from edge of cinder track to east; marked by granite block, 8 by 8 by 16 inches (20 by 20 by 41 centimeters), top face of which is lettered C. I. W., 1916, with a small hole marking exact instrument center and left 2 inches (5 cm.) above ground. True bearings: pole at south end of race-course, surmounted by triangle, 9° 33′.7; pole with circular disk at southwest corner of course, 20° 18′.7; bottom of staff on rightmost tower of stable building, 88° 10′.6; right gable end of stable building, 103° 09′.5; bottom of marking pole in northeast corner of course, 197° 10′.8; bottom of high pole in southeast corner of course, half mile, 354° 06′.1.

Tola Gol, Outer Mongolia, 1915.—North of road from Urga to Barron Kurin, about 600 feet (183 meters) northeast of point where road enters ford across river, about 90 feet (27.5 meters) east of east bank of river, and about 500 feet (152 meters) north of base of hills extending eastward from river.

Tongkow, Inner Mongolia, 1916.—Among sandhills, about 200 feet (61 meters) west of west bank of Yellow River, about 600 feet (183 meters) northeast of north end of village, about 500 feet (152 meters) northeast of first telegraph-pole on west bank of river. True bearings: bottom of first telegraph-pole on west bank of river, 30° 27′.6; bottom of top mast of telegraph-pier across river, 307° 39′.1; center of window in obo, 900 feet (274 meters), 329° 20′.0.

Towshakwan, Yunnan, 1916.—In one of small terraced fields on hillside north of village, about 300 feet (91 meters) southeast of southeast edge of grave-land extending up hill, about 250 feet (76 meters) north of nearest house, 7 paces from edge of bank to east, 15 paces from edge of bank to south. Magnetic bearings: bottom of left edge of westmost tomb on hill, 126° 30′.1; center ornament on temple, about 400 feet (122 meters), 309° 11′.7; bottom of telegraph-pole near large tree, at point where rough road to station joins path along north edge of village, 349° 00′.7.

Tsangchow, Chihli, 1915.—Outside city in open space in compound of London Mission station, 95 feet (29.0 meters) south 28° 40′.3 east of northwest corner of open space, 137 feet (41.8 meters) south 58° 40′.2 west of northeast corner of wall of open space, 86 feet (26.2 meters) north of near end of small brick building; marked by two bricks placed together on end with tops left just beneath surface of ground and small cross cut in top face. True bearings: center of bottom of near down-spout of large house, 170 feet (52 meters), 10° 49′.3; top of leftmost star-shaped ornament in wall, 180 feet (55 meters), 16° 10′.0; eye of ornamental fish at left end of house, 150 feet (46 meters), 189° 32′.5; near corner of chimney on house at right, 100 feet (30.5 meters), 292° 49′.3; bottom of near pillar of entrance to residence, 100 feet (30.5 meters), 338° 22′.5; bottom of center of near chimney of small building, 90 feet (27 meters), 358° 09′.0.

Tsaohokow, Shengking, Manchuria, 1916.—About half mile (0.8 km.) southwest of railway station, on waste land just northeast of junction of two small rivers, about 400 feet (122 meters) east of Chinese village, about 100 feet (30 meters) from river bank, about 60 feet (18 meters) from edge of field to east, about 120 feet (37 meters) south of cart track. True bearings: near gable end of altar-house of village, 300 feet (91 meters), 118° 56′.5; right gable end of railway station,

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Tsaohokow, Shengking, Manchuria, 1916—continued. 219° 06′.7; near gable end of Japanese shrine, one-third mile (0.5 km.), 242° 37′.7; bottom of signal arm on railway, one-fourth mile (0.4 km.), 260° 26′.7.

Tsinan, Shantung, 1915.—On recreation-ground of Shantung Christian University, about 300 feet (91 meters) south of residence No. 8, 356 feet (108.5 meters) southwest of southwest corner of residence No. 7; marked by a stone block, 6 by 6 by 20 inches (15 by 15 by 51 cm.), with top inscribed C. I. W. 1915, a drill-hole marking precise point, and sunk just beneath surface of ground. True bearings: near gable end of rightmost of forestry buildings on hill, one-third mile (0.5 km.), 50° 53′.6; top of water-tower, 2 miles (3 km.), 117° 12′.2; center ornament on roof of temple, 1 mile (1.6 km.), 140° 59′.9; bottom of flagstaff on Medical College, 187° 37′.1; southwest corner of residence No. 7, 217° 12′.5; top of pagoda on hill, 3 miles (5 km.), 311° 36′.2.

Tsingshih, Hunan, 1915.—On common land about 600 feet (183 meters) north-northwest of Finnish Mission station and roughly in line with its east compound-wall, and about 200 feet (61 meters) south of a foot-path leading across common. True bearings: center ornament on roof of house west of compound-gate, 600 feet (183 meters), 27° 49′.8; top of ornamental tower in city, one-third mile (0.5 km.), 57° 50′.2; center ornament on roof of temple, half mile (0.8 km.), 271° 11′.6; center ornament on nearer temple, 310° 02′.4.

Tsingshuiho, Shansi, 1916.—In flat river valley, east of east gate of town, near northwest corner of cultivated tract which stands at higher level than rest of valley and contains a number of trees, at a point about 650 yards directly in front of east portal a line to which crosses stream a little below row of stepping stones. True bearings: outer edge of southern side of red sandstone midway base of east portal arch of town, about one-fourth mile (0.4 km.), 92° 04′.4; eastern edge of wall of temple on cliffside, about one-fourth mile (0.4 km.), 203° 28′.8; vertical axis of chimney on stone hut down valley, about half mile (0.8 km.), 231° 24′.2.

Tsitsihar, Heilungkiang, Manchuria, 1915.—In Chinese public park, about 700 feet (0.2 km.) southwest of Imperial Russian consulate, 20.2 feet (6.16 meters) southwest of large prominent tree near edge of steep bank forming west boundary of park, 4 paces east of edge of bank, 151.5 feet (46.18 meters) northwest of northeast corner of Lama temple inclosure; marked by three gray bricks placed on end, forming column 11 by 5 by 6 inches (28 by 13 by 15 cm.) with cross cut in top face, left just beneath surface. True bearings: top of band-stand on race-course, half mile (0.8 km.), 141° 12′.5; near corner of leftmost chimney on large red-roofed house, three-fourths mile (1.2 km.), 147° 07′.1; near gable end of rear gate of consulate, 1,000 feet (0.3 km.), 203° 37′.1; top of near drain pipe of vice-consul's house, 700 feet (213.3 meters), 227° 30′.6; bottom of rightmost post of summer pavilion, 350 feet (106.7 meters), 258° 23′.6; top of leftmost of two large chimney stacks, three-fourths mile (1.2 km.), 313° 23′.0; bottom of northeast wall of Lama temple inclosure, 333° 51′.8.

Tsitsihar, Heilungkiang, Manchuria, 1916.—On waste land on south edge of present settlement, about half mile (0.8 km.) along main road leading south-southwest from railway station, about 500 feet (152 meters) east of road, south of and in line with ruined mud wall forming east side of a compound, 105 paces northeast of cart road, 53 paces south of cart road skirting south edge of settlement, 95 paces south of wooden peg at southeast corner of ruined mud wall. True bearings: center of highest chimney of red house, 800 feet (244 meters), 129° 54′.9; top of railway water-tower, 174° 34′.5; cross on church tower, half mile (0.8 km.), 185° 18′.0; near corner of old east wall of compound, 197° 17′.0; near gable of entrance to school, half mile (0.8 km.), 226° 09′.4; top of left chimney of railway building, 1 mile (1.6 km.), 250° 20′.7.

Tsunchü, Szechwan, 1916.—On left bank of stream, about 5 miles (8 km.) below Mowchow, near southwest corner of cultivated field lying between town and river, bounded by low stone walls and separated from field to south by path which is continuation westward of alley joining village street at a point just south of inn, 12 feet (3.7 meters) east of western boundary of field, 12 feet (3.7 meters) north of south boundary, and 37 paces northwest of west wall of village yards.

Tsungkow, Kwangtung, 1917.—On south bank of Han River, opposite west outskirts of Tsungkow, just west of telegraph-line where it crosses river, on sandy strip inclosed by small stream and large clump of bamboos, about 500 feet (152 meters) west of high telegraph-mast on south bank, 70 paces east of east edge of clump of bamboos, 52 paces west of west bank of stream, and 17 paces from flood bank of river. True bearings: right end of roof ridge of westmost of 3 houses, about 250 feet (76 meters), 58° 47′.0; bottom of high telegraph-mast on north bank of river, 174° 59′.0; near gable end of white-fronted house down river, 1 mile (1.6 km.), 238° 35′.2; right gable end of large well-built house down river, 1 mile (1.6 km.), 239° 24′.4; near gable end of large solitary house on river bank, half mile (0.8 km.), 244° 08′.7; bottom of high telegraph-mast on south bank of river, 264° 02′.1.

Tsunhwachow, Chihli, 1915.—Near ruined buildings in compound of Methodist Mission just outside south wall of city, south of main path leading west to gate between two sections of compound, between first two trees of row bordering path on south, 8.7 feet (2.65 meters) west of most eastern tree and 9.9 feet (3.02 meters) east of second tree; marked by conical hole cut in top face of building stone 3 by 4 inches (8 by 10 cm.) in horizontal section, sunk nearly flush with ground. True bearing: right edge of brick pillar just south of gateway in yard wall, about 110 yards (100 meters), 87° 34′.7.

Tsunyi, Kweichow, 1915.—In old city in recreation-grounds of the Tsunyi Middle School, which is situated alongside Silk School, 92 feet (28.0 meters) from east wall, 146 feet (44.5 meters) from southeast corner of Middle School compound, and 83 feet (25.3 meters) a little south of east from southeast corner of school building; marked by stake 3 by 3 by 18 inches (8 by 8 by 46 cm.) set even with surface of ground, and having two saw-cuts in top to mark precise position. True bearings: top of center ornament of temple, 400 feet (122 meters), 10° 55′.3; center of ornament over gate of barracks, 150 feet (46 meters), 73° 37′.0; near corner of wall of school, 100° 31′; center ornament over entrance to Middle School, 180 feet (55 meters), 147° 36′.9; leftmost pillar to right of gate, 200 feet (61 meters), 194° 36′.0; southeast corner of wall, 322° 59′.

Tuanchialing, Chihli, 1915.—Near western end of village, in open space north of westernmost houses; in northwest quarter of elevated level stony tract bounded on west and north by deep cart roads, 6 feet (1.8 meters) south of large forked locust tree standing alone. True bearings: vertical axis of prominent conical mountain peak, 233° 48′.4; left edge of chimney of house, about 100 yards (91 meters), 300° 41′.3.

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Tuanyuantsun, Chihli, 1915.—Southeast of village, on north slope of valley trending eastward about 500 paces southeast of south gate of village, in midst of burial-ground and directly across valley from conical hill on top of which is a lone pine tree. True bearings: peak of distant conical mountain, 24° 06′.8; vertical axis of base of lone pine tree on top of conical hill, 319° 38′.4.

Tumuntsz, Szechwan, 1916.—Near small mountain hamlet of Tumuntsz, about 5 miles (8 km.) due west of Chowtien, in middle of small level threshing floor on top of rocky shoulder projecting southward from main road from which it is reached by passing through yard of a farmer's house. True bearing: base of telegraph-pole near short flight of steps in main road, about half mile (0.8 km.), 94° 47′.6.

Tungchingwan, Szechwan, 1916.—Halfway between Yütingpu and Taipingchan, south of main road just west of red-sandstone bridge over stream, on northwest slope of hill called Tungchingwan, opposite single small hut used as wayside restaurant on small level spot about 14 by 14 feet (4.3 by 4.3 meters) above base of hill and below space occupied by graves on top of hill.

Tungchow, Chihli, 1915.—On campus of North China Union Arts College in grounds of American Board Mission near railway station of Paotung-ssu, near southwest corner of level plateau on which are main hall and dormitory, 26.7 feet (8.14 meters) east of southernmost tree on western edge of plateau, and 63.5 feet (19.35 meters) west of tree on south edge; marked by cross cut in top face of dressed stone 4 by 4 inches (10 by 10 cm.) projecting about 6 inches (15 cm.) above ground. True bearings: most northern corner of dormitory building, about 300 yards (274 meters), 257° 24′.9; southernmost corner of stone ledge marking first floor of main building of college, about 300 yards (274 meters), 276° 51′.1.

A second stone was placed to mark meridian 457.5 feet (139.45 meters) from station, just south of hedge in front of residence of Rev. M. S. Frame, 42.7 feet (13.01 meters) east of eastern side of paved pathway leading from gate to house, and 18.5 feet (5.64 meters) north of center of main path in front of faculty row.

Tungchwan Yun, Yunnan, 1916.—About midway along east side of a grassy open space used as military parade-ground, about one-fourth mile (0.4 km.) southwest of west gate of city, in a line drawn tangent to north side of horse-ring, from second tree from north of row along west side of grounds, 238 feet (72.5 meters) east of tree, and 106 feet (32.3 meters) east of point of tangency, 44 feet (13.4 meters) west of low mud garden-wall, 275 feet (83.8 meters) south of its northwest corner, and 24 feet (7.3 meters) west of footpath. True bearings: top of prominent tomb on hillside, one-fourth mile (0.4 km.), 66° 29′.4; northmost tree of row along west side of ground, about 250 feet (76 meters), 90° 20′.2; ornament on small temple in west suburb, one-fifth mile (0.3 km.), 106° 22′.3; ornament on temple at base of hill across plain, 2 miles (3 km.), 146° 38′.2; northwest corner of mud garden-wall, 176° 49′.9; near gable end of roof ornament on gateway, 400 feet (121.9 meters), 211° 10′.4; center ornament on rear building of temple, 350 feet (106.6 meters), 262° 17′.6.

Tungfufeng, Shensi, 1915.—East of village of Tungfufeng, halfway between Hingpin and Wukung and 15 miles (24 km.) from each, 40 paces south of main road and 56 paces north of 12th telegraph-pole from east wall of town counting pole in line with east wall, 4 feet (1.2 meters) west of east side of cultivated strip, 8 paces wide from east to west, and 17 paces north of center of grave-mound, approximately 9 by 9 feet (3 by 3 meters).

Tungkwan Yun, Yunnan, 1917.—Just beyond north end of village, a little below small saddle on which northmost houses are situated, on grassy north slope of hill forming south side of a large rice valley, about 400 feet (122 meters) south of group of four farmhouses lower on hillside, about 300 feet (91 meters) west of nearer of two prominent trees on lower slope of hill north of saddle. True bearings: left gable end of temple in valley, half mile (0.8 km.), 113° 34′.4; center veranda-post of temple, one-fourth mile (0.4 km.), 163° 10′.9; near gable end of nearest of farm buildings on hillside, 184° 21′.1; bottom of prominent tree on hill, north of saddle, 282° 28′.

Tungkwossu, Kansu, 1916.—About one-fourth mile (0.4 km.) southwest of Tibetan lamasery, on a low bank, 20 paces south of the edge of bank, and 10 paces from west side of a small road leading to Koko Nor. True bearings: top of grave at west outskirt of lamasery, 179° 32′.0; ornament on temple at foot of mountain and to left of green-roofed temple, 207° 48′.2; ornament on roof of lower and nearer temple, 212° 42′.0; largest ornament on roof of main Tibetan temple, 220° 21′.2; top of large grave of lama, 226° 58′.8.

Tunglu, Chekiang, 1917.—On right bank of river, opposite Tunglu, about one-third mile (0.5 km.) above ferry landing, near Chang Yuan P'u, two farm-houses on river bank across from stone steps forming boat landing midway along water-front of town, on small level grassy shelf just below top of bank, and 46 paces southwest of path from farmhouses. True bearings: near gable end of white-fronted temple, 1 mile (1.6 km.), 55° 26′.6; center roof ornament on gate-tower at south end of town, half mile (0.8 kilometer), 115° 10′.8; near gable end of white-fronted house near boat landing, one-third mile (0.5 km.), 144° 54′.9; center ornament on tower at north end of town, half mile (0.8 km.), 168° 33′.5; top of ruined pagoda, half mile (0.8 km.), 183° 43′.6; ferry landing on right bank of river, 225° 49′.

Tuyünfu, Kweichow, 1915.—In inclosed recreation-ground of Tuyünfu Middle School, 42 feet (12.8 meters) from west wall of inclosure, 132 feet (40.2 meters) south of left side of passage in north wall, 134 feet (40.8 meters) from southeast corner of ground, and about 100 feet (30 meters) from southwest corner; marked by a hardwood peg 3 inches (8 cm.) in diameter driven flush with surface of ground. True bearings: southwest corner of inclosure, 17° 17′; top of conical peak, 1.5 miles (2.4 km.), 137° 05′.5; left side of passage in north wall, 189° 52′.5; center spike on roof of temple on hill, one-third mile (0.5 km.), 230° 45′.1; center ornament on roof of house at south end of ground, 338° 28′.2.

Tzeli, Hunan, 1915.—Near north end of large stony island in the Ling Kiang, about 400 feet (122 meters) west-northwest of ferry steps on right of river, roughly in middle of high ground about 40 feet (12 meters) from north bank of island. True bearings: center ornament on temple, half mile (0.8 km.), 25° 26′.6; center ornament on temple, three-fourths mile (1.2 km.), 67° 22′.8; top of ornament on temple at north end of town, one-third mile (0.5 km.), 247° 12′.5; near gable of house on right bank of river near ferry steps, 500 feet (152 meters), 287° 58′.8; ornament on

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Tzeli, Hunan, 1915—continued.
square tower, one-fourth mile (0.4 km.), 325° 24′.7; right gable end of yamen building, 500 feet (152 meters), 351° 34′.6.

Tzeliutsing, Szechwan, 1916.—On premises of Canadian Methodist Mission, on playground of boys' primary school, near eastern edge of plateau, in projected line of northern wall of inclosure around residence occupied by Rev. R. E. S. Taylor, and 51.2 feet (15.61 meters) east of northeast corner. Magnetic bearing: south edge of terraced wall on hill, about 1 mile (1.6 km.), 288° 40′.

Uhtergar Narin-in Gol, Outer Mongolia, 1915.—About 900 feet (274 meters) north of Urga to Uliassutai courier road at point where it crosses river called Uhtergar Narin-in Gol, about 30 paces from east bank of river.

Urga, Outer Mongolia, 1915.—On unoccupied Russian government land, north of Russian graveyard, in line with west side of graveyard fence, 240 feet (73.1 meters) north-northwest of northwest corner of graveyard, 316.5 feet (96.47 meters) northwest of northeast corner of graveyard; marked by gray brick, top end of which is left just below ground. True bearings: bottom of cross on church of old consulate, 1,000 feet (305 meters), 43° 07′.3; top of prayer-tower of temple at base of hill, 1.5 miles (2.4 km.), 49° 30′.3; gilt ball over Buddha's house, 2 miles (3.2 km.), 58° 00′.2; bottom of chimney stack of brewery, 800 feet (244 meters), 230° 12′.4; northeast corner of Russian graveyard, 316° 00′; bottom of flagstaff over consulate, one-fourth mile (0.4 km.), 323° 55′.2; bottom of cross on chapel, 400 feet (122 meters), 338° 20′.5; northwest corner of graveyard, 346° 12′.

Wana, Yunnan, 1917.—On small grassy space above grave land, 42 paces southwest of west gate of village, 23 paces south of main road, 11 paces west of hedge. True bearings: bottom of leftmost of two palm trees on hill, about 600 feet (183 meters), 156° 06′.0; right end of roof of large house on hill, about 300 feet (91 meters), 190° 29′.8; right end of roof ridge of large house in village, 1,000 feet (0.3 km.), 260° 19′.4; bottom of solitary tree on mountains, 3 miles (4 km.), 350° 04′.8.

Wanghuo, Shansi, 1915.—Near western edge of cultivated field on east side of stony river-bed along east wall of village, 115 paces from village wall measured at right angles from a point 56 paces northeast of archway of east gate of village, 6 paces northwest and 50 paces southwest from low stone walls perpendicular to and parallel to river bank respectively. True bearings: vertical axis of V cut between prominent twin conical mountain peaks, 65° 55′.4; tip of small shrine on high hill across bed of main stream, 349° 09′.9.

Wanhsien, Szechwan, 1916.—On right bank of Yangtze Kiang, nearly opposite upper end of huge rock in midstream known as "the thousand catty rock," on sandy, pebblestrewn shelf south of rocky promontory opposite upper end of city, at a point just above small gully cut in sand by rivulet. True bearings: tip of tower on temple on hill to left of upper end of city, 120° 31′.4; cross on Catholic Cathedral in city, 141° 29′.8.

Weichow, Szechwan, 1916.—In rear yard of premises of China Inland Mission, in vegetable garden, at a point 75 feet (22.9 meters) south of rear wall of back building of mission, which forms north wall of garden, and 40 feet (12.2 meters) west of east mud wall.

Wenchow, Chekiang, 1917.—In northeast corner of city, in northeast corner of tract belonging to and adjoining

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Wenchow, Chekiang, 1917—continued.
English Methodist College, to be used as recreation-field for college, now used as vegetable garden, at base of steep rocky hill, 16.3 feet (4.97 meters) northwest of middle boundary stone, and 51.25 feet (15.62 meters) southwest of northeast boundary stone; marked by a granite block 4 by 5 by 30 inches (10 by 13 by 76 cm.) with raised cross half inch (1 cm.) above top of stone indicating exact center, left about 5 inches (13 cm.) above surface of ground. True bearings: upper half of southeast corner of superintendent's house, 200 feet (61 meters), 12° 45′.4; bottom of northwest corner of college building, about 250 feet (76 meters), 47° 04′.0; lone tree on mountain, 5 miles (8 km.), 86° 03′.8; tip of ornament at left end of small temple, about 150 feet (46 meters), 123° 47′.1; top of northeast boundary stone of garden, 218° 13′.6.

Wingshun, Kwangsi, 1917.—On north bank of West River, about one-fourth mile (0.4 km) west of launch anchorage, which is opposite Likin station on river bank, about 700 feet west of prominent temple overlooking river, known as "San Chai Ssu" (Three Religions Temple), on small piece of waste grass-land on east side of junction of small stream with river, about 30 paces from top of north bank of river, about 3 paces from small irrigation ditch to west, about 10 paces from footpath to northeast. True bearings: top of pagoda down river, three-fourths mile (1.2 km.), 61° 31′.3; near gable end of rear temple building of San Chai Ssu, 267° 16′.5; near gable end of front building of San Chai Ssu, 273° 03′.5; bottom of large spreading banyan tree across river, 339° 02′; near gable end of temple across river, about one-fourth mile (0.4 km.), 358° 16′.9.

Wüchai, Shansi, 1915.—Within a roughly triangular grassy plot bounded on north and southeast by two roads and on west by a gully, 36 paces east of a point in gully which is 250 paces south of southern corner of city wall, in line between two boulders whose exposed portions are approximately 2 by 3 feet (0.6 by 0.9 meter) and 15 inches (38 cm.) high, 10.3 feet (3.14 meters) southeast of southeast corner of boulder in northwest corner of plot and 17.7 feet (5.39 meters) northwest of northwest corner of boulder east of road; marked by rectangular block of shale 3 by 3 by 9 inches (8 by 8 by 23 cm.) sunk flush with ground. True bearings: peak of south gable end of small tower on city wall near east gate, 151° 55′.4; southern edge of small building north of prominent lone tree, on top of farthest visible hill, 227° 21′.5.

Wuchow, Kwangsi, 1915, 1917.—Two stations, designated *1915* and *1917*, were occupied, being approximate reoccupations of C. I. W. station of 1907. Station *1917* is about 20 feet (6 meters) south-southwest of statiod *1915*, and is on lawn, east of residence of British consul, on top of hill overlooking junction of Fu ann West rivers, 20 feet (6 meters) from base of eleventh fir tree from northeast corner of lawn, 31.2 feet (9.51 meters) from nearby willow tree, 69.7 feet (21.24 meters) from top of near corner of steps of wooden platform overlooking Fu River, 105 feet (32.0 meters) from southeast corner of residence. True bearings: bottom of near corner of residence, 74° 59′.8; center of left pillar of small pavilion on hill, half mile (0.8 km.), 235° 56′.3; right gable end of fort, 1.5 miles (2.4 km.), 266° 32′.1; near gable end of Wuchow Hotel, one-third mile (0.5 km.), 287° 12′.8; right gable end of Standard Oil shed across river, half mile (0.8 km.), 306° 09′.4.

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Wukangchow, Hunan, 1915.—Two stations, designated *A* and *B*, were occupied. Station *A* is near middle of level open ground west of district official's yamen, and 58½ feet (17.8 meters) east of west wall of city, 112 feet (34.1 meters) and 129 feet (39.3 meters) respectively from northwest and southwest corners of yamen wall. True bearings: top of conical peak, 5 miles (8 km.), 18° 15′.1; left gable end of house, half mile (0.8 km.), 20° 43′.2; middle of door of white farmhouse, 2 miles (3.2 km.), 25° 45′.4; top of tower on city wall, three-fourths mile (1.2 km.), 174° 29′.3; center ornament on roof of temple, three-fourths mile (1.2 km.), 200° 26′.8; top of square tower of brick building, one-third mile (0.5 km.), 225° 41′.4; northwest corner of yamen wall, 229° 34′; southwest corner of yamen wall, 328° 01′. *B* is on open ground about half mile (0.8 km.) from east gate of city, and about 400 feet (122 meters) northwest of pagoda.

Wuting, Shantung, 1915.—Inside city, in recreation-ground of Wuting grammar school, 48.5 feet (14.78 meters) south of north mud wall of recreation-ground inclosure, 79.5 feet (24.2 meters) northeast of corner in west wall of inclosure, 82 feet (25.0 meters) southeast of northwest corner of ground; marked by two bricks placed together on end with small cross cut in top face, left just below surface of ground. True bearings: corner in west wall of compound, 55° 56′; northwest corner of recreation-ground, 126° 37′; tip of ornament on left end of roof of temple, 500 feet (152 meters), 147° 52′.8; fork in tail of fish at left end of roof of large school building, 300 feet (91 meters), 220° 02′.9; center ornament on roof of temple, 120 feet (37 meters), 261° 45′.0; fork in tail of fish on roof of house, 120 feet (37 meters), 346° 12′.8.

Yachowfu, Szechwan, 1916.—On northern slope of ridge which carries south wall of city, at a point nearly due south of residence of Rev. H. Openshaw of American Baptist Mission, about 75 feet (23 meters) south of mud wall bounding south yard behind district yamen, and about 135 feet (41 meters) west of east wall line of yamen inclosure projected. True bearing: tip of white pagoda on hill, about 1 mile (1.6 kilometers), 188° 01′.6.

Yangkai, Yunnan, 1917.—On northeast side of large field, 175 paces along cart road leading southeast from south gate of village, about 70 feet (21.3 meters) south-southeast of solitary pine tree on north side of road, 5 paces from bank forming northeast side of field. True bearings: near ornament on south gate of village, 500 feet (152.4 meters), 119° 33′.8; top of distant pagoda on mountain, 7 miles (11 km.), 141° 51′.8; bottom of solitary pine tree, 159° 28′.2; top of pagoda on hill, 2 miles (3.2 km.), 247° 27′.5; near gable end of rightmost building near white house on hill, 1 mile (1.6 km.), 275° 16′.1; bottom of tree along north side of field, about 300 feet (91 meters), 298° 12′.7.

Yenanfu, Shensi, 1915.—In center of small back-yard of yamen of Hsien, about 15 feet (4.6 meters) north of south wall. True bearing: dividing line between brown and white sections of south wall in next yard as seen through gate, about 65 feet (20 meters), 242° 36′.0.

Yenmunkwan, Shensi, 1915.—About 33 miles (53 km.) north of Yenanfu on road from Suitehchow, on southern slope below summit of mountain pass, in line with center of stone archway and temple marking pass, and 50 yards (46 meters) south of archway.

Yenpingfu, Fukien, 1917.—On property of Methodist Episcopal Mission on hilltop in western part of city, in boys' school- and residence-compound, in northeast corner of tennis-court, 300 feet (91 meters) northeast of residence of Mr. Caldwell, about 130 feet (40 meters) northwest of gate-house, 40 feet (12.2 meters) southwest of corner of compound wall, 22.7 feet (6.92 meters) from east wall of compound, 35.7 feet (10.88 meters) from north wall of compound, and 110.5 feet (33.68 meters) from near corner of gate; marked by a hard bluestone block, 4 by 8 by 20 inches (10 by 20 by 51 cm.), with small cross cut in top face to indicate exact point, and set level with surface of ground. True bearings: ornament on tower of doctor's house, 11° 37′.2; center of top gable of Mr. Caldwell's residence, 67° 39′.3; top of northeast corner of compound-wall, 203° 23′; ornament on tower of ladies' residence, one-fourth mile (0.4 km.), 204° 48′.9; top of pagoda on left bank of river, 1 mile (1.6 km.), 284° 22′.6; top of pagoda on right bank of river, 1.5 miles (2.4 km.), 305° 40′.4; bottom of southwest corner of gate-house, 343° 05′.5.

Yichesun, Yunnan, 1916.—On summit of small pine-clad hill at south end of village, south of grove of pine trees, on grass-land between edge of field on top of hill and grove, about 250 feet (76 meters) southeast of rear building of old temple, 3 paces north of edge of field, 3 paces from pine tree nearest southeast corner of grove on hill. True bearings: near gable end of small white temple, 1 mile (1.6 km.), 63° 12′.1; top of ornament at left end of temple building, 145° 15′.8; top of small pagoda, about 200 feet (61 meters), 186° 04′.5; left pillar of two stone memorial pillars on hill, half mile (0.8 km.), 195° 47′.5; left end of roof scroll of small house, 400 feet (121.9 meters), 257° 19′.4.

Yingchow, Shansi, 1915.—Within rectangular, level, uncultivated tract, 28 by 44 paces, elevated about 1 meter above surrounding cultivated fields, the northwest corner about 20 paces south of north side and 15 paces east of west side of tract whose northwest corner is 141 paces east of southeast corner of city wall. True bearings: tip of tower on southwest corner of city wall, about one-fourth mile (0.4 km.), 91° 19′.4; vertical diameter of knob seen over wall between southeast corner and first buttress of east wall north of corner, 119° 43′.1; gable end of tower on northeast corner of city wall, 166° 35′.4.

Yingpanshui, Kansu, 1916.—At west end of village, on scrub-covered flat between river and bank on which village is built, about 180 feet (55 meters) southeast of largest of five "li" pillars on top of bank, about 22 paces from foot of bank, and about the same from edge of scrub along swampy margin of small river. True bearings: center of chimney of mud house, 400 feet (122 meters), 104° 03′.6; center of top of largest of five "li" pillars, 144° 28′; near ornament on nearest temple building, one-fourth mile (0.4 km.), 239° 50′.1; center ornament on main temple building, one-fourth mile (0.4 km.), 240° 46′.1

Yochow, Hunan, 1916.—At port of Yochow, not city proper, on custom-house property, near flagpole and signal-pole north of commissioner's residence, at a point 65 paces northeast of flagpole; marked by oak post, about 6 by 6 by 30 inches (15 by 15 by 76 cm.), with top face lettered C. I. W. 1916, with a drill-hole indicating exact point, left about 4 inches (10 cm.) above ground. True bearings: west edge of northmost-chimney of commissioner's house, about 600 feet (183 meters), 4° 38′.4; top of pagoda at Yochow City, about 2.5 miles (4 km.), 28° 17′.2.

Yüanchow Hun, Hunan, 1915.—In south corner of grounds of agricultural experiment station, on slight elevation

ASIA.

CHINA—*continued.*

Yüanchow Hun, Hunan, 1915—continued. behind a temple, about half mile (0.8 km.) from east gate of city, 100.5 feet (30.63 meters) from south corner of mud wall about grounds, and 45½ feet (13.87 meters) from nearest point of southeast wall; marked by stone block 10 by 10 by 12 inches (25 by 25 by 30 cm.) projecting slightly above ground. True bearings: south corner of agricultural experiment-station grounds, 13° 50′; top of spike on tower of temple, 1,200 feet (366 meters), 86° 38′.5; center ornament on roof of gate-house, 400 feet (122 meters), 105° 48′.2; top of right gate-post of superintendent's house, 800 feet (244 meters), 196° 51′.9; top of spike on roof of meteorological station, 700 feet (213 meters), 206° 43′.5; top of ornament on distant pagoda, 5 miles (8.0 km.), 350° 18′.5; top of ornament on small pagoda, one-third mile (0.5 km.), 351° 30′.3.

Yulinfu, Shensi, 1915.—On unoccupied level tract at western side of city, in middle of low ridge between cultivated fields, 66 paces west of west side of small octagonal kiosk at end of first street running west north of Chung Ling inn, about 300 yards (274 meters) south of southwest corner of wall of temple in line with its western wall. True bearing: right side of outermost post of first story of tower over west gate of city, about one-third mile (0.5 km.), 144° 42′.8.

Yungan Fu, Fukien, 1917.—On waste stony bushland, about midway between right bank of Sha River and a small river which flows into it opposite west gate of city, about one-fifth mile (0.3 km.) north of northwest corner of city wall which lies in line with an ornamental tower on hills behind city, and 300 feet (91 meters) west of old temple with a wooden theatrical stage. True bearings: center roof ornament on long temple inside west city wall, one-fourth mile (0.4 km.), 8° 17′.3; near gable end of west gate of city, one-third mile (0.5 km.), 15° 16′.7; top ornament on southmost of four memorial arches across river, one-fifth mile (0.3 km), 124° 05′.1; tail of ornamental fish at left end of roof of gray temple, 600 feet (183 meters), 211° 48′.8; center of top window of old pagoda, half mile (0.8 km.), 215° 09′.6; center roof ornament on old theatrical stage, 253° 25′.6.

Yungchang, Yunnan, 1917.—At west end of military parade-ground, which is a large grassy area about one-fourth mile (0.4 km.) north of north gate of city, in line with row of wooden pillars along north side of pavilion at west end of ground, 10 paces north of footpath, 224 feet (68.3 meters) east of northeast pillar of pavilion. True bearings: left end of roof ridge of small house over north gate, one-fourth mile (0.4 km.), 1° 02′.2; top of pagoda 1 mile (1.6 km.), 69° 27′.6; center ornament of small temple on hill, three-fourths mile (1.2 km.), 79° 45′.7; bottom of northeast pillar of pavilion, 106° 01′.3; leftmost pillar in gate-house on main road, half mile (0.8 km.), 227° 35′.0; center ornament on temple, one-fourth mile (0.4 km.), 254° 41′.0; bottom of right side of blank wall at east end of ground, about 900 feet (274 meters), 291° 09′.8.

Yunghinghsien, Hunan, 1915.—On left bank of Lei River, about 350 feet (107 meters) north of public ferry landing at north end of town, 90 feet (27.4 meters) northeast of stone road leading to ferry, and 20 feet (6.1 meters) from edge of river. True bearings: near end of ridge pole of farmer's house, 250 feet (76 meters), 119° 22′.5; lone pine on hillside, one-fourth mile (0.4 km.), 190° 43′.3; left gable end of house, 600 feet (183 meters), 244° 38′.2; right edge of temple on opposite side of river, 400 feet (122 meters), 247° 47′.6; left gable end of large house across river, 1,000 feet (305 meters), 320° 40′.1.

ASIA.

CHINA—*continued.*

Yungshunfu, Hunan, 1915.—On military parade-ground inside city, about 800 feet (244 meters) south of east gate, about 130 feet (40 meters) west of east wall, and 330 feet (100 meters) south of southeast corner of wall of old temple at north edge of parade ground; marked by natural rock of which about 6 by 12 inches (15 by 30 cm.) protrudes slightly above surface of ground, and on which a 4-inch (10 cm.) cross was cut to mark precise point. True bearings: top of pagoda, one mile (1.6 km.), 19° 06′.0; center ornament of temple on hillside, half mile (0.8 km), 121° 50′.7; top of woman's memorial, 350 feet (107 meters), 156° 46′.7; bottom of right wall of temple, 330 feet (100 meters), 177° 18′.6; center of ornament on roof of top building of temple, one-fourth mile (0.4 km.), 269° 06′.3; north end of mountain range 279° 54′.

Yungting, Hunan, 1915.—On low stony island in the Ling Kiang about one mile (1.6 km.) southeast of Yungting, about 270 feet (82 meters) west of eastern extremity of island, and 57 feet (17.4 meters) from its south bank, and about 300 feet (91 meters) north of bungalow belonging to Finnish Mission on right bank of river. Magnetic bearings: top of conical peak, 7 miles (11 km.), 127° 24′; top of pagoda, one-third mile, (0.5 km.), 150° 32′; ornament on wayside temple, 1,000 feet (305 meters), 236° 54′; bottom of left edge of bungalow, 342° 08′.

Yungting, Fukien, 1917.—On west bank of Yungting River, near east gate of city, on waste bush land, about 200 feet (61 meters) southeast of English Presbyterian Mission chapel, 14 paces east of cobbled path along river bank and opposite a point on path 250 paces south of bridge. True bearings: near edge of roof ridge of nearest mission building, 128° 29′.4; left gable end of large house on hillside across river, one-fourth mile (0.4 km.), 223° 59′.3; bottom of stone pillar alongside temple on opposite bank, about 600 feet (183 meters), 330° 23′.0.

Yünnanfu, A, Yunnan, 1917.—About 50 feet (15 meters) south of station of 1911, as latter is no longer desirable on account of growth of trees, in large garden owned by British consulate, between north gate of city and military barracks, in center of lawn which forms northeast corner of ground, 45.2 feet (13.78 meters) from cedar tree on left of drain to east, 80.2 feet (24.44 meters) northwest of near corner of summer pavilion, 84.7 feet (25.82 meters) from westmost cedar tree in hedge to northwest, 53.5 feet (16.3 meters) from edge of lawn to southwest. True bearings: bottom of left edge of large gravestone on hill, 1 mile (1.6 km.), 86° 19′.2; rightmost of two grave pillars on hill, 1 mile (1.6 km.), 86° 42′.4; top of summer pavilion, about 100 feet (30 meters), 304° 58′.3.

Yünnanfu, B, Yunnan, 1917.—In east corner of lawn of large garden owned by British consulate, outside north gate of city, 11.5 feet (3.50 meters) from northeast edge of lawn, 19 feet (5.8 meters) west of nearest cedar tree, 28 feet (8.5 meters) northwest of top of earth bank, 46.2 feet (14.08 meters) east of *Yünnanfu A,* 49.2 feet (15.00 meters) northwest of nearest corner of summer pavilion. True bearings: left edge of large tombstone on hill, half mile (0.8 km.), 86° 26′.1; rightmost of two stone pillars on hill, half mile (0.8 km.), 86° 45′.2, *Yünnanfu A,* 90° 06′.7; top of summer pavilion, 334° 45′.4.

Yunnanyi, Yunnan, 1917.—In northeast corner of graveland on lower slopes of hill rising from southwest corner of village, 160 paces up path which turns off main street to south, about 300 feet (91 meters) east

ASIA.

CHINA—*concluded*.

Yunnanyi, Yunnan, 1917—continued.
of west end of village, 6 paces west and 28 paces south of hedges forming boundaries of fields on east and north respectively, 19 paces east of path. True bearings: near edge of large grave-monument on hill-side, 300 feet (91.4 meters), 87° 09′.4; leftmost of two grave-pillars of large tomb across valley, half mile (0.8 km.), 213° 37′.1; center ornament on tower at east end of village, one-third mile (0.5 km.), 261° 07′.2.

Zikawei Observatory, 1917.—See Lukiapang.

INDIA.

Bhamo, Upper Burma, 1917.—Exact reoccupation of G. T. S. magnetic station. At east end of cantonment land, about one-fourth mile (0.4 km.) north of military barracks and one-fourth mile (0.4 km.) south of custom-house, a large red building with red compound-wall, almost in line with and 159 feet (48.5 meters) from nearer of two large trees growing close together to southeast, 108 paces from cart road to northwest; marked by 12 inch (30 cm.) square concrete block projecting 5 inches (13 cm.) above the ground, with top face marked G. T. S. Magnetic Station, the letter "n" in "Magnetic" marking exact center of station. True bearings: near roof ornament on left-most of three long barrack buildings, 22° 29′.8; nearest ornament on brown bungalow, one-fourth mile (0.4 km.), 53° 36′.0; top of pagoda spire, half mile (0.8 km.), 81° 21′.0; top of gilt pagoda of Buddhist temple, one-fourth mile (0.4 km.), 113° 26′.2; left ornament on mission house, half mile (0.8 km.), 150° 45′.5; left side of custom-house, 162° 54′.6; top of brick survey-pillar near main road, about 700 feet (213 meters), 182° 41′.9; base of nearby tree, 302° 48′.

Kulonghka, Upper Burma, 1917.—About 200 feet (61 meters) southeast of first inn on left as village is entered from north, in small clearing at junction of two jungle tracks, 44 paces along path leading south-east from south corner of inn inclosure, 7 paces south-east of junction of two paths, 4 paces from path to southwest.

JAPAN.

Sugita, Tokaido, 1918.—Practical reoccupation of station of 1906, on west shore of Tokio Bay, in village of Sugita, on small inlet known as Mississippi Bay, on main road from Yokohama, 25 meters northeast of road measured from a point about 60 meters north-west of turn in road just north of tunnel, in line with southeast face of Kridzunikwan Hotel or tea-house on opposite side of road, and 5 meters from shore; marked by wooden peg driven flush with surface of ground. True bearing: right-hand one of two tripod-like beacons in Tokio Bay near examination anchorage, 233° 51′.8.

SIBERIA.

Khabarowa,[1] 1918.—Station of "Maud Expedition" and a close reoccupation of station of August 1, 1893, of "Norwegian North Polar Expedition." On left bank of river, between river and coast, in extension of side nearest river of old chapel 12 meters down-stream from nearest corner. True bearing: indentation in low mountains on east coast of Yugor Schar, 15 to 20 kilometers, 259° 10′.6; a second indentation less conspicuous than former, 257° 43′.5.

Port Dickson, 1918.—Station of "Maud Expedition," southwest of radio station. True bearings: radio mast, 241° 33′; conspicuous stone on summit of hill seen beyond a small island, 318° 53′. A mound of stones was built upon site of station.

ASIA.

SIBERIA—*concluded*.

Vaigach (*also Waigatsch*),[1] 1918.—A station of "Maud Expedition," southwest of south end of narrow isthmus between small bay and lake, at base of short spur of land jutting into sea westward.

STRAITS SETTLEMENTS.

Singapore, Botanical Gardens, 1914, 1918.—Station of 1918 is a close reoccupation of that of 1914, and is 3 meters from a 6-inch cast-iron water pipe laid between 1914 and 1918. On stretch of level ground south of Cluny Lake, at base of grassy hill leading to assistant curator's house, 62 feet (18.9 meters) northeast of road leading through gardens from Tyersall Road to garden offices, and 126 feet (38.4 meters) southeast of south corner of lake; marked by stone block 6 by 7 by 12 inches (15 by 18 by 30 cm.) with small cross cut in top face, left 1 inch (3 cm.) above surface of ground. True bearings: west edge of white chimney, 174° 04′.8; left end of cement bank, 177° 13′.7.

Singapore, Holland Road, 1918.—On Holland Road, about 3 miles (5 km.) south of Botanical Gardens, on small hill, property of government, reserved for triangulation station; marked by granite block similar to those used for triangulation stations. True bearings: triangulation station, 81° 26′.8; flagstaff of signal station, 323° 29′.6.

AUSTRALASIA.

AUSTRALIA.

Abercromby Well, Western Australia, 1914.—On flat east of Abercromby Well, on road between Lawlers and Wiluna, about 1,000 feet (305 meters) east of telegraph-line, and 372 feet (113.4 meters) east of well dump. True bearings: telegraph-pole just to left of well, 1,000 feet (305 meters), 79° 03′.2; center of well, 372 feet (113.4 meters), 80° 18′.

Adelaide (*South Park*), *South Australia*, 1914.—Exact reoccupation of station of 1911, the lead-filled pipe placed by South Australia Survey Department to mark station being recovered. Near northern end of South Park, southeast of tennis-courts and on line joining Flinders Column on Mount Lofty and point on west boundary of park about 1.25 chains (25 meters) south of building line at northeast corner of King William Street and South Terrace, 45 feet (13.7 meters) southeast of largest of group of fir trees. True bearings: spire of church near corner of park on King William Street, 300 yards (274 meters), 117° 45′.0; flagpole on post-office tower, two-thirds mile (1.1 km.), 161° 17′.0; flagpole on brick building, 221° 15′.7; Flinders Column on Mount Lofty, very distant, 293° 19′.5. The disturbing effect of electric tramways was easily noticeable.

Albany, Western Australia, 1914, 1916.—Exact reoccupation of station of 1912, in park lands reserve, 68.5 feet (20.88 meters) west of Moir Street, at Middleton Bay, on top of low ridge which runs parallel to road; marked by jarrah peg sunk just below ground. True bearings: Breaksea Island Lighthouse, 290° 47′.2; flagstaff on brow of hill, 359° 49′.4.

Alger Island, Northern Territory, 1914.—On beach of most southerly bay on west side of Alger Island, about 300 feet (91 meters) north-northwest of old trepang camp used by Lineacre, about 1⅓ miles (2 km.) from south point of island, and 35 feet (10.7 meters) from edge of sandy beach; marked by peg projecting about 4 inches (10 cm.) above ground. True bearings: high-water mark on rocks of south point of bay, 1⅓ miles (2.1 km.), 10° 59′.9; north end of Napier Peninsula, 4 miles (6.4 km.), 26° 17′.3; end of vegeta-

[1] This station is in European Russia.

AUSTRALASIA.

AUSTRALIA—*continued.*

Alger Island, Northern Territory, 1914—continued. tion on north point of bay, half mile (0.8 km.), 144° 14′.8; center of base of straight bushy tree, 210 feet (64.0 meters), 150° 27′.6; bottom of leftmost post of framework of trepang hut, 200 feet (61.0 meters), 326° 08′.6.

Angaston, South Australia, 1915.—In cricket and football oval in Angaston Park, 36.9 feet (11.25 meters) east of center of east end of cement portion of cricket pitch. True bearings: south post of pavilion, outside edge, 88° 07′.4; center of gable ornament of pavilion, 92° 30′.9; north post of pavilion, outside edge, 96° 57′.1; center of top of pagoda, 125° 50′.3; top part of center of dedication monument, 177° 54′.6; edge of north wall of Agricultural Hall, 179° 34′.6.

Arnhem Bay, Northern Territory, 1914.—On sandy beach at large break in mangroves on right bank of wide salt arm in southwest corner of Arnhem Bay, at south end of gap in mangroves, three-fourths mile (1.2 km.) from mouth, about 40 feet (12 meters) from high-water mark, and 40 feet (12 meters) from salt swamp to eastward; marked by round peg projecting about 4 inches (10 cm.) above ground, also a post 13 feet (4.0 meters) high 56 feet (17.1 meters) north-northwest from station.

Bald Hill, Western Australia, 1914.—North of government well at Bald Hill, in line with trough, and 323 feet (98.5 meters) from fence inclosing trough; marked by jarrah peg driven flush with ground. True bearings: top of bolt in northeast corner post of fence surrounding trough, 8° 12′.3; trigonometric station on Bald Hill, about 2 miles (3.2 km.), 347° 05′.6.

Ballaballa, Western Australia, 1914.—On flat open ground 446 feet (135.9 meters) west of railway from Balla jetty to Whim Well Mine, and about 550 feet (168 meters) southwest of wharfinger's office; marked by peg projecting slightly above ground. True bearings: trigonometric station on Depuch Island, 7 miles (11.3 km.), 136° 20′.7; righthand post of platform on wharfinger's office, 227° 48′.3; left post on porch of Mr. Macdonald's house, 1 mile (1.6 km.), 345° 21′.4.

Balladonia, Western Australia, 1914.—On bare rocky land west of telegraph-station, in line with south wall inclosing telegraph-station, also in line with continuation of wire fence on east side of field to northward, 374.5 feet (114.15 meters) from southwest corner of telegraph-office wall, 334.5 feet (101.95 meters) from corner post of fence to northward, and 145.5 feet (44.35 meters) from nearest telegraph-pole to southward. True bearing: left top corner of middle chimney of telegraph-office, 259° 53′.4.

Batchelor, Northern Territory, 1914.—Close reoccupation of station of 1912, on ridge south of government experimental farm, about 150 yards (137 meters) south-southeast from men's quarters, about 100 yards (91 meters) west-northwest from manager's old quarters, 15 feet (4.6 meters) south of buggy track, and 9.5 feet (2.90 meters) northwest from tall tree marked with cross 6 feet (1.8 meters) above ground. True bearings: top of center gable of stable, 400 feet (122 meters), 134° 49′.3; right gable of stable, about 450 feet (137 meters), 138° 41′.9; leftmost ornament on manager's house, about one-fourth mile (0.4 km.), 148° 45′.5; near gable end of men's quarters, 450 feet (137 meters), 165° 31′.8; corner post in north side of paddock, one-third mile (0.5 km.), 254° 31′.9.

Bathurst Island, Northern Territory, 1914.—See Mission Station.

Batten's Creek, Northern Territory, 1914.—See Ryan's Bend.

AUSTRALASIA.

AUSTRALIA—*continued.*

Beachport, South Australia, 1914.—On recreation-reserve, about 300 yards (274 meters) northeast of railway station, and 93.5 feet (28.50 meters) south of fence along road to northward measured at right angles from point 361.0 feet (110.03 meters) east of bend in fence. True bearings: tip of Penguin Island Lighthouse, 1° 40′.2; near corner of leftmost chimney of coffee palace, 4° 30′.7; railway signal in front of Bay View Hotel, 24° 25′.9; finial on school, 45° 29′.7; straining-post at angle of fence to westward, 115° 29′.4; straining-post at angle of fence to eastward, 274° 50′.1; tip of railway signal, 290° 38′.8.

A secondary station was established 74 feet (23 meters) north of magnetic station, in line with station and Penguin Island Lighthouse.

Bedford Park, Western Australia, 1914.—See Broome B.

Bench-Mark 56½, South Australia, 1914.—In dense scrub country near a camel pad and close to bench-mark 56½ miles (90.93 km.) east of Ooldea Bore, of Chalmer's survey of East-West (transcontinental) Railway from Port Augusta to Kalgoorlie; marked by mallee post projecting 1 foot (30 cm.) above ground.

Billowaggi, Western Australia, 1914.—On Canning stock route, 31.5 feet (9.60 meters) from abandoned well shaft, on edge of claypan west of well No. 43. True bearing: left support of well windlass, 170 paces, 277° 05′.

Birdsville, Queensland, 1914.—On a small flat-topped sand mound about one-fourth mile (0.4 km.) east of town, one-third mile (0.5 km.) west of Diamentina Creek, 93.3 feet (28.44 meters) south of highest point of rocky knoll, 25 feet (7.6 meters) south of pile of broken bottles, and 250 feet (76 meters) north of track leading to ford at Diamentina Creek; marked by eucalyptus peg projecting 2 inches (5 cm.) above ground. True bearings: gable of small white galvanized-iron shed at south end of town, one-third mile (0.5 km.), 71° 50′.5; near corner of stone chimney of house, one-fourth mile (0.4 km.), 77° 53′.5; north corner of right chimney of Royal Hotel, one-fourth mile (0.4 km.), 81° 55′.6; gable end of plain stone building, one-fourth mile (0.4 km.), 87° 18′.7; gable end of small galvanized-iron shed, one-fourth mile (0.4 km.), 94° 53′.4; highest point of stony knoll, 93.3 feet (28.44 meters), 198° 26′.6.

Black Rocks, Northern Territory, 1914.—At top of gentle slope on right bank of McArthur River, about 16 miles (26 km.) above river's mouth, about 700 yards (640 meters) above rocky bar in river, and about 50 yards (46 meters) south of line of mangroves along river bank.

Blackwood, South Australia, 1914.—Three stations, designated *A*, *B*, and *C*, were occupied on land belonging to Sir G. Downer, west side of road between Blackwood and Belair; the land is being sold for building lots and future recovery of stations is doubtful. *A* is 240 feet (73.2 meters) northwest of northwest corner of Methodist church, and 260 feet (79.2 meters) from nearest point of main road. True bearings: leftmost post of white fence in front of cottage, 1,200 feet (366 meters), 209° 12′.1; railway semaphore, one-fourth mile (0.4 km.), 251° 39′.8; near corner of church, 240 feet (73.2 meters), 318° 11′.8.

Station *B* is 100 feet (30.5 meters) from *A*, on azimuth line to leftmost post in front of cottage. True bearings: leftmost post of white fence in front of cottage, 1,100 feet (335 meters), 209° 12′.1; spike of porch of house, 300 feet (91 meters), 325° 40′.7.

AUSTRALASIA.

AUSTRALIA—*continued.*

Blackwood, South Australia, 1914—continued.
Station *C* is 100 feet (30.5 meters) from *B* on azimuth line to leftmost post of white fence in front of cottage. True bearings: leftmost post of white fence in front of cottage, 1,000 feet (305 meters), 209° 12′.1; post of porch on house, 350 feet (107 meters), 334° 17′.0.

Bookooloo, South Australia, 1914.—On sandy loam flat covered with scrub, about 1,000 feet (305 meters) west of transcontinental railway and northwest of railway station; marked by brass plug in top of a concrete pillar 8 by 8 inches (20 by 20 cm.) projecting 10 inches (25 cm.) above ground and carrying on its west face a small brass tablet marked with an upright arrow. True bearing: gable end of goods-shed, 1,000 feet (305 meters), 289° 22′.8.

Booleroo Center, South Australia, 1916.—In south portion of public recreation-ground, half mile (0.8 km.) east of township, in space between oval inclosure and outside fence of recreation-ground, 198 feet (60.35 meters) south of an aluminum peg; marked by a survey reference-mark of cement, flush with ground, and inscribed Geodetic and Magnetic Survey of South Australia on outer circle, and λ 138° 21′.0 E, ø 32° 53′.0 S on cross arms. True bearings: shoulder of Mount Remarkable, 115° 13′.6; spire of Roman Catholic church, 132° 11′.6; post at corner of road, 198° 31′.8; 27th mile post, 221° 21′.3.

Border Town, South Australia, 1914, 1916.—Station of 1914 was a practical reoccupation of station of 1911. On common near race-track, 94 feet (28.7 meters) northeast of large gum tree; marked by triangular jarrah peg. True bearings: near corner of stone house, 600 feet (183 meters), 26° 34′.3; near corner of old cemetery, 226° 58′.4; near corner of stone house, 525 feet (160 meters), 290° 22′.9; gable edge of Institute, ¼ mile (0.4 kilometer), 347° 19′.1.

Station of 1916 is approximate reoccupation of station of 1911 and 1914. On race-track, 210 yards (192 meters) southwest of 182½-mile post on railway, and 220 yards (201 meters) from near rail of railway. True bearings: center, near ground, of distant railway signal post, 235° 54′.9; center of 182½-mile post, 245° 17′.9; north corner post of small cemetery surrounded by iron railings, 303° 20′.7.

Bore A, South Australia, 1914.—Near bore *A* on East-West (transcontinental) Railway, on Nullarbor Plain; marked by mallee peg projecting 3 inches (8 cm.) above ground, set by *E* division of Furner's preliminary survey and marked "38.00" (38 miles 00 chains).

Bore B, South Australia, 1914.—On Nullarbor Plain, 330 feet (100.6 meters) south of cairn marking site chosen for bore *B*, marked by peg 68.00 (68 miles 00 chains) of *E* division of Furner's survey of East-West (transcontinental) Railway. True bearing: hurricane lamp on cairn of stones marking site of bore, 330 feet (100.6 meters), 179° 13′.0.

Borroloola, Northern Territory, 1914.—On town reserve south of police-station inclosure, and in line with southeast fence of inclosure; marked by stake projecting 1 inch (3 cm.) above ground and covered with small mound of earth. True bearings: left gable end of iron building, about 1,400 feet (427 meters), 1° 03′.3; trigonometrical station on Mt. Bernard, 1.5 miles (2.4 km.), 168° 59′.6; west corner of police yard, 300 feet (91 meters), 181° 12′.0; spike on left end of front building of police station, 380 feet (116 meters,) 199° 51′.8; south corner of police-inclosure fence, 190 feet (57.9 meters), 221° 22′.5; leftmost veranda post

AUSTRALASIA.

AUSTRALIA—*continued.*

Borroloola, Northern Territory, 1914—continued.
of hotel, 1,600 feet (488 meters), 347° 00′.6; spike on stockyard shelter, about 1,500 feet (457 meters), 354° 10′.4.

Bow Creek, Western Australia, 1914.—About one-fourth mile (0.4 km.) north of Bow River, and 200 yards (183 meters) west of Turkey Creek-Wyndham road.

Bowen Straits Aboriginal Station, Northern Territory, 1914.—On edge of cliffs, about 500 feet (152 meters) west of Aboriginal station, and approximately in line with north side of protector's house, 25 feet (7.6 meters) south of edge of cliff, 18 feet (5.5 meters) north of path, and 42 feet (12.8 meters) northwest of tree marked C. I. W.; marked by cement block 9 by 9 by 21 inches (23 by 23 by 53 cm.) marked C. I. W. 1914. True bearings: end of vegetation on point across Brown's Bay, 1½ miles (2.4 km.), 123° 24′.6; near corner of trepang house at Brown's Camp, one-third mile (0.5 km.), 256° 05′.4; top of leftmost veranda post of house, 269° 22′.8; top of rightmost post of veranda of house, 275° 01′.1; near gable end of kitchen, 280° 41′.2; blazed tree marked C. I. W., 42 feet (12.8 meters), 316° 47′.7.

Bramble Cay, 1915.—On highest point of island, near center of Bramble Cay sand-bank, and 92 feet (28 meters) almost due north of large beacon. True bearing: left peak of Darnley Island, 28 miles (45 km.), 12° 45′.

Brenton Bay, Northern Territory, 1914.—At sharp bend forming point on right side of mouth of large creek at head of Brenton Bay on north side of Melville Island, about 120 feet (37 meters) north 44° west of point, and 120 feet (37 meters) from highwater mark; marked by stake projecting 1 foot (30 cm.) above ground and covered by cairn of rocks. True bearings: left end of long sandy beach across bay, 1½ miles (2.4 km.), 51° 00′.1; tree at right end of long beach across bay, 1⅓ miles (2.1 km.), 84° 48′.1.

Brisbane, Queensland, 1914.—Exact reoccupation of C. I. W. magnetic station of 1913. In Victoria Park, on slope below Children's Hospital, 206.5 feet (62.94 meters) from corner of Children's Hospital fence at intersection of streets, and 233.5 feet (71.17 meters) from right corner of Children's Hospital fence; marked by sandstone post 6 by 6 by 15 inches (15 by 15 by 38 cm.) sunk 1 inch (3 cm.) below ground and lettered on top C. I. W. 1913. True bearings: right cross on convent, half mile (0.8 km.), 6° 17′.1; center of spike on building at Brisbane Grammar School, three-fourths mile (1.2 km.), 37° 23′.1; Children's Hospital fence at street corner, 155° 01′.7; left ventilator on Children's Hospital, 350 feet (107 meters) 179° 21′.1; corner of fence bounding Children's Hospital, 228° 27′.8; center of top of rear tower of museum, one-fourth mile (0.4 km.), 294° 42′.1; center of top of right front tower of museum, one-fourth mile (0.4 km.), 301° 50′.5; top of St. Paul's Church steeple, three-fourths mile (1.2 km.), 350° 58′.5.

Bromby's Islands, Northern Territory, 1914.—On open ground about 100 yards (91 meters) southeast of western end of most southerly of Bromby's Islands, east of an old native well, 43 feet (13.1 meters) southwest of an isolated clump of scrub, about 130 feet (40 meters) from high-water mark measured in direction of a large bushy casuarina tree which stands 112 feet (34.1 meters) south 41° 12′ west of station and just to right of line from station to right edge of Cape Wilberforce about 1 mile (1.6 km.) distant; marked by round peg projecting about 6 inches (15 cm.) above ground and witnessed by a post 11 feet

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AUSTRALIA—*continued.*

Bromby's Islands, Northern Territory, 1914—continued. (3.4 meters) high 19 feet (5.8 meters) from station in line with casuarina tree. True bearings: right end of Cape Wilberforce, 40° 22′.8; vertical line in profile of left end of Rocky Island, about 3 miles (4 km.), 55° 45′.6; fold in hills on Cotton Island seen over right end of Rocky Island, about 6 miles (10 km.), 70° 49′.5; overhanging crag of rocky hill on island, one-fourth mile (0.4 km.), 292° 26′.8.

A secondary station was established at a point 300 feet (91 meters) north-northeast of magnetic station, to test for local disturbance.

Broome, A, Western Australia, 1914.—On open ground almost due south of wireless station, about half mile (0.8 km.) west of jetty, 204 feet (62.2 meters) southwest from west end of north arm of cattle-lead, and 210 feet (64.0 meters) northwest from west end of south arm of same lead; marked by peg driven 2 inches (5 cm.) below ground. True bearings: top of wireless pole, one-third mile (0.5 km.), 171° 29′.5; top of flagpole on freight sheds, about one-fourth mile (0.4 km.), 239° 06′.8.

Broome, B, Western Australia, 1914.—In center of Bedford Park in front of Continental Hotel, about 120 feet (37 meters) south of west post of gate on north side of park. True bearing: beacon at end of jetty, about 1¼ miles (2 km.), 356° 02′.4.

Bunabie, South Australia, 1914.—On rising ground about 400 feet (122 meters) southeast of Bunabie tanks, 300 feet (91 meters) south of telegraph-line, 12 feet (3.7 meters) southwest of a gutter which joins another gutter 72 feet (21.9 meters) farther to the northwest; marked by rough piece of limestone 2 by 3 inches (5 by 8 cm.) projecting 5 inches (13 cm.) above ground. True bearings: center of pump-post, 400 feet (122 meters), 125° 09′.3; northeast corner post of tank-yard, 500 feet (152 meters), 132° 22′.8.

Bunbenoo, Western Australia, 1916.—Three stations were occupied, about 1 mile (1.6 km.) west of Bunbenoo Spring, in a small clear space on south side of salt-flat extending east and west past Bunbenoo Spring. Station *A* is marked by a rough peg 1.5 inches (4 cm.) in diameter, projecting about 3 inches (8 cm.) above ground. True bearings: tree on horizon, about 4 miles (6 km.), 334° 56′.8.

Station *B* is about 710 feet (216 meters) south 32° 09′.0 east of station *A*; marked by a rough peg 1.5 inches (4 cm.) in diameter, projecting about 3 inches (8 cm.) above ground.

Station *C* is about 710 feet (216 meters) south 27° 48′.8 west of station *A* and about same distance west of station *B*; marked by a rough peg 1.5 inches (4 cm.) in diameter, projecting 3 inches (8 cm.) above ground.

Bunbury, Western Australia, 1914.—A wire fence having been built within a few inches of C. I. W. station of 1912, a new station was established 36 feet (11.0 meters) west of old one and 52 feet (15.8 meters) from west fence inclosing the reserve. True bearings: nearer cross on cemetery shelter, 79° 53′.1; spike on tennis-pavilion, 142° 55′.8; top of lighthouse, 193° 29′.0; beacon on breakwater, 202° 25′.0; left edge of higher water-tank, 227° 56′.2; cross on Congregational church, 276° 00′.5.

Burracoppin, Western Australia, 1916.—Four stations were occupied, designated *A*, *B*, *C*, and *D*. Station *A* is about 1 mile (1.6 km.) south of Burracoppin railway station, on old town site, 319.5 feet (97.38 meters) northwest of northwest corner of fence around well, 194 feet (59.1 meters) north-northwest of nearest point in center of road, 59.5 feet (18.14 meters) south-

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AUSTRALIA—*continued.*

Burracoppin, Western Australia, 1916—continued. southeast of a prominent stump, and 45.8 feet (13.96 meters) northwest of a prominent stump; marked by a wooden peg 1.5 by 1.5 inches (4 by 4 cm.) left level with surface of ground. True bearing: triangular cairn on granite hill, about three-eighths mile (0.6 km.), 357° 58′.1.

Stations *B*, *C*, and *D* are on a sand-plain, about 3 miles (5 km) northeast of Burracoppin railway station, and 2.7 miles (4.35 km.) north of railway at point where it crosses rabbit-proof fence. Station *B* is 271.2 feet (82.66 meters) east on a line perpendicular to fence line, measured from one hundred and sixteenth post south of 3-mile post; marked by a peg 2 by 4 inches (5 by 10 cm.), left with top projecting slightly above surface of ground. Station *C* is 700 feet (213 meters) south 60° east from station *B*; marked by a stake 2 by 4 inches (5 by 10 cm.) projecting slightly above surface of ground. Station *D* is about 700 feet (213 meters) north 30° east from station *B*; marked by a stake 2 by 4 inches (5 by 10 cm.) projecting slightly above surface of ground. Stations *B*, *C*, and *D* are at the angles of an equilateral triangle with sides approximately 700 feet (213 meters) long, the line joining *C* and *D* being approximately true north and south.

Bynoo, Northern Territory, 1914.—In home garden of Cooper's settlement, about 500 feet (152 meters) northeast of dwelling, 200 feet (61 meters) south-southeast from north corner of garden, and 50 feet (15.2 meters) southwest of northeast fence. True bearings: right gable end of mission hut on Bathurst Island, one-third mile (0.5 km.), 40° 48′.8; left gable end of Cooper's house, 44° 16′.2; north corner of home garden, 155° 58′.0.

Cadelga, South Australia, 1914.—In paddock on flat ground southwest of homestead buildings, in a sharp bend of Nappamilkie Creek, which forms two sides of paddock, 142.5 feet (43.43 meters) southwest of nearest point of fence, and 205.5 feet (62.64 meters) west of west gate-post in fence; marked by peg projecting 3 inches (8 cm.) above ground. True bearings: south edge of well-coping, 300 feet (91 meters), 136° 47′.0; extreme west edge of building, 900 feet (274 meters), 231° 08′.5; gable end of east building of homestead, 900 feet (274 meters), 235° 30′.5; top of west corner of strainer-post at near gate, 264° 31′.2.

Cadell's Landing, Northern Territory, 1914.—Southeast of the old camp on right bank of Liverpool River, about 200 feet (61 meters) southeast of landing used by Cadell Expedition opposite Bat Island, 34 feet (10.4 meters) north 60° 25′ east of light-wood tree, and 57 feet (17.4 meters) east of bank of river; marked by black mangrove peg projecting 1 inch (3 cm.) above ground.

A secondary station was established about 250 feet (76 meters) from magnetic station, in line with azimuth mark, to test for local disturbance.

Cahill's Landing, Northern Territory, 1914.—Near small landing used by Oenpelli Protector of Aborigines on East Alligator River, about 60 miles (97 km.) from mouth, about 400 feet (122 meters) southeast of post at landing, 50 feet (15.2 meters) northwest of west bank of creek, and southwest of prominent tree on edge of creek. True bearing: post at landing, 144° 38′.8.

Cape Cockburn, Northern Territory, 1914.—On open sandy flat at extreme end of Cape Cockburn, about 350 feet (107 meters) north of old trepang camp, about 400 feet (122 meters) north of end of cape, and 111 feet (33.8 meters) east of high-water mark; marked by

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AUSTRALIA—*continued.*

Cape Cockburn, Northern Territory, 1914—continued. wooden post projecting about 1 foot (30 cm.) above ground and covered with cairn of rocks about 18 inches (46 cm.) high. True bearings: leftmost stem of casuarina tree, 79 feet (24 meters), 24° 10′.3; end of Coombe Point, about 8 miles (13 km.), 37° 28′.5; left end of Copeland Islands, about 14 miles (23 km.), 45° 54′8; V-shaped gap at west end of Valencia Island, 5 miles (8 km.), 49° 55′.5; right end of Valencia Island, 6 miles (9.7 km.), 69° 28′.1; bottom of left side of trepang hut, 450 feet (137 meters), 354° 57′.4.

Cape Croker, Northern Territory, 1914.—In southwest corner of large rough open flat on west side of north end of Cape Croker, south of a long reef running out to sea, 48 feet (14.6 meters) northeast of clump of pandanus palms, and 152 feet (46.3 meters) east of 3-foot (1-meter) cairn built around a 7-foot (2.1-meter) post on edge of bank; marked by block of cement 8 by 8 by 18 inches (20 by 20 by 46 cm.) marked C. I. W. 1914 set flush with ground and covered with small mound of rocks. True bearings: rightmost pandanus palm of clump, 68° 59′.8; cairn on edge of low bank, 101° 25′.8.

Cape Hotham, Northern Territory, 1914.—On edge of beach on west side of Cape Hotham, about 2 miles (3.2 km.) southwest of north end of cape, about half mile (0.8 km.) northeast of point bordered with mangroves, about 80 feet (24.4 meters) from high-water mark, and 79 feet (24.1 meters) northwest of tree marked C. I. W.; marked by peg driven flush with ground and covered with rocks. True bearings: end of vegetation on west point of Cape Hotham, 213° 30′.8; bottom of casuarina tree, about 1 mile (1.6 km.) along beach, 219° 00′.8; marked tree, 79 feet (24.1 meters), 307° 18′.8.

Cape Leeuwin, Western Australia, 1914.—On left side of road from Augusta to Cape Leeuwin Lighthouse, 36 feet (11.0 meters) from road, and 83.5 feet (25.45 meters) south-southwest of road survey peg; marked by jarrah peg driven flush with ground. True bearings: figure 1 of date on lighthouse, 9° 31′.7; peak of Cumberland Rock, 125° 46′.5; peak of St. Alouarn Island, 299° 01′.5.

Cape Wessel, Northern Territory, 1914.—On most northerly of Wessel Islands forming Cape Wessel, about midway of shore of small bay on west side of island, 28 feet (8.5 meters) from edge of beach; marked by stake projecting 2 feet (61 cm.) above ground. True bearings: bottom of leftmost pandanus palm on hill to west, three-fourths mile (1.2 km.), 90° 47′.6; end of scrub across bay to left, three-fourths mile (1.2 km.), 108° 57′.0; end of scrub on north point of bay, three-fourths mile (1.2 km.), 180° 14′.0.

A secondary station was established 250 feet (76 meters) distant, in direction of azimuth mark, to test for local disturbance.

Cardanumbi, Western Australia, 1914.—On southeast side of road between Balladonia and Eucla, 27 feet (8.2 meters) from nearest point of road, 414 feet (126.2 meters) northeast of north corner of fence inclosing water-tanks, and in line with northwest line of fence; marked by jarrah peg projecting slighlty above ground. True bearing: hole in center of east corner post of tank inclosure, 36° 44′.4.

Carnarvon, Western Australia, 1914.—On town common on north side of creek, about 800 feet (244 meters) north-northeast of Gascoyne Hotel, 65 paces from north end of small foot-bridge over creek at north end of Foss Street, which is seen in line with right end of hotel and 11 paces west of path. True bearings: near rail of foot-bridge, 20° 32′.5; right gable end of Gascoyne Hotel, 21° 26′.1; near gable end of shed to right of hotel, 23° 40′.0; top of lighthouse at jetty, 3 miles (4.8 km.), 102° 49′.6; top of spike on roof of red house, two-thirds mile (1.1 km.), 270° 21′.0; near gable end of building to left of Pearson Cole Building, one-fourth mile (0.4 km.), 327° 03′.3; bottom of flagstaff at left end of building, one-fourth mile (0.4 km.), 355° 06′.1.

Carnding Well, South Australia, 1914.—In southeast corner of old horse yard at Wilgena station, about 600 feet (183 meters) east of Carnding Well, and north of mail-track; marked by jarrah peg painted white, projecting 3 inches (8 cm.) above ground. True bearings: fence post at northwest corner of field on south side of track, 300 feet (91 meters), 54° 03′.2; hurricane lamp on well, 81° 21′.4; near corner of old shed, 73.6 feet (22.43 meters), 102° 12′.5; far gate-post, 131.0 feet (39.93 meters), 340° 13′.7.

Carraweena, South Australia, 1914.—On hard sand patch on west bank of Strzelecki Creek, west of mail-track, about 800 feet (244 meters) south of ruins of homestead, and 182 feet (55.5 meters) northwest of wire fence beyond the mail-track and parallel with it; marked by inverted bottle buried 4 inches (10 cm.) below ground. True bearings: west corner of ruined homestead, 189° 50′.1; near corner of ruined homestead, 193° 40′.1; east corner of mail-change hut, 750 feet (229 meters), 228° 35′.2; center of large notched post, 183.9 feet (56.05 meters), 270° 47′.6; tall fence-post, 182.2 feet (55.53 meters), 303° 33′.9.

Carthole Water-Hole, South Australia, 1914.—At the foot of west slope of large sand-hill, one-third mile (0.5 km.) west of water-hole, and 70 feet (21 meters) west of junction of two tracks; marked by peg projecting 6 inches (15 cm.) above ground. True bearing: left side of left post of old mail-change yard halfway up sand-hill, 370 feet (113 meters), 238° 56′.5.

Cheese Tin, Western Australia, 1914.—About half mile (0.8 km.) east of road, 50 yards (46 meters) north of creek.

Christlieb Well, South Australia, 1914.—On slightly rising ground about 30 yards (27 meters) south of small tributary of Arckaringa Creek, and about 300 yards (274 meters) west of Christlieb Well. True bearings: Mt. Arckaringa, 4 miles (6 km.), 222°; highest conical peak to northeast, 249° 59′.1; center of Christlieb Well, 273° 34′.9.

Clayton Bore, South Australia, 1914.—On small hillock between two creeks, about 900 feet (274 meters) north-northeast of homestead, and about 400 feet (122 meters) east of mail-track to Hergott Springs; marked by mulga peg projecting 3 inches (8 cm.) above ground and covered with stones. True bearings: gable of homestead, 19° 59′.8; extreme south post of small stock-yard, 300 feet (91 meters), 64° 49′.5; extreme north post of stock-yard, 350 feet (107 meters), 82° 04′.9; trigonometric station Hayes' Hill, on Clayton Creek, 4 miles (6.4 km.), 268° 51′.3; center of bore, 900 feet (274 meters), 289° 05′.7.

Connell's Creek, Northern Territory, 1914.—Practical reoccupation of C. I. W. station of 1912. Near small landing on Woolner aboriginal reserve on creek emptying into Chambers Bay, about 20 miles (32 km.) east of Adelaide River, about half mile (0.8 km.) above mouth of creek, in open plain west of mangroves fringing west bank of creek. True bearings: right edge of mangrove fringe, 400 feet (122 meters), 34° 20′.9; straight pandanus palm on plain, 1½ miles

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AUSTRALIA—*continued.*

Connell's Creek, Northern Territory, 1914—continued. (2.4 km.), 81° 10′.8; leftmost pandanus palm of clump on plain, half mile (0.8 km.), 95° 38′.4; rightmost pandanus palm in clump on plain, 99° 11′.7; left edge of mangrove fringe, 300 feet (91 meters), 160° 51′.9; thick tree with hole at bottom of trunk to right of passage through mangroves, 600 feet (183 meters), 277° 39′.1.

Coolgardie, Western Australia, 1914.—Exact reoccupation of C. I. W. station of 1912. In park lands on north side of town, in section bounded by Toorak, Moran, MacDonald, and Jobson streets, 429 feet (130.8 meters) from southwest corner, 258 feet (78.6 meters) from south fence, and 48 feet (14.6 meters) north-northeast of gum tree. True bearings: northwest corner of park lands reserve, 600 feet (183 meters), 149° 56′.6; left gable end of Presbyterian church, one-fourth mile (0.4 kilometer), 299° 30′.7; cross on right gable end of Catholic church, 330° 05′.2; center of cross of left gable of convent, 345° 25′.4.

Cordillo Downs, South Australia, 1914.—On low flat ground east of water-course of Pollatuckera water-hole, 150 feet (45.7 meters) south of cleared track to Arabury, and 300 feet (91 meters) east of east edge of water-course; marked by pile of stones 1 foot (30 cm.) high and 2 feet (61 cm.) in diameter. True bearings: north side of small window of wool-shed, one-third mile (0.5 km.), 99° 23′.6; near corner of south stone chimney of bake-house, one-third mile (0.5 km.), 114° 16′.3; near corner of store, one-third mile (0.5 km.), 116° 29′.2; near corner of chimney of homestead, 1,500 feet (457 meters), 121° 46′.4; south side of chimney-stack of wool-scouring plant, 1,200 feet (366 meters), 126° 50′.1; pumping-rod of windmill, one-fourth mile (0.4 km.), 127° 59′.1.

Cottesloe, Western Australia, 1914, 1916, 1920.—For the purpose of making intercomparisons of instruments, three stations were occupied in 1914, and two in 1920, in the Government Educational Endowment Reserve, in Osborne District, Cottesloe, near Perth, northeast of junction of Grant Street and Marmion Street. Station *A* is 240.5 feet (73.30 meters) northeast of sign-post at southwest corner of reserve, and 160.2 feet (48.83 meters) north of telegraph-pole in north edge of Grant Street; marked by a jarrah post 1½ by 2½ inches (4 by 6 cm.) sunk slightly below surface of ground. True bearings: bottom of left end of fence by quarry, three-fourths mile (1.2 km.), 20° 14′.3; top of sign-post at corner Grant and Marmion streets, 51° 34′.9; near gable of house on hill, 52° 34′.6; spike on front gable of house, one-third mile (0.5 km.), 120° 40′.7; ornament on left gable of Methodist church, one mile (1.6 km.), 205° 17′.7; ornament on roof of near house, 263° 12′.4.

Station *A* was exactly reoccupied in 1916, and *A* and *B* in 1920.

Stations *B* and *C* were established on the line from the left end of fence by quarry through station *A*, station *B* being 110 feet (33.5 meters) north-northeast of station *A* and station *C* being 110 feet (33.5 meters) north-northeast of station *B*.

Cow Creek, Western Australia, 1914.—On Canning stock route along Cow Creek, between Sturt Creek and Flora Valley station, about 11 to 12 miles (18 to 19 km.) north from Anjammie or "20-Mile Water Hole" on Sturt Creek.

Cranbrook, Western Australia, 1916.—See Eleven-mile Dam.

Croker Island, Northern Territory, 1914.—See Cape Croker.

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Cue, Western Australia, 1914.—In northwest corner of football-ground, on west side of road to Day Dawn, 92 feet (28.0 meters) southeast of wooden fence surrounding playing-pitch; marked by jarrah peg set just below ground. True bearings: base of flagpole on grand-stand, about 180 feet (55 meters), 43° 35′.5; chimney of mine, about 2 miles (3.2 km.), 90° 26′.7; right edge of water-tanks by railway, about three-fourths mile (1.2 km.), 253° 18′.9; left gable end of hospital, about one-third mile (0.5 km.), 329° 52′.8.

Currie, Tasmania, 1914.—Two stations, designated *A* and *B*, were established on King Island. *A* is in southwest corner of paddock, 87.5 feet (26.67 meters) north of fence, and about 1,000 feet (305 meters) southwest of lighthouse; marked by hardwood peg set just below ground. True bearings: left post of near gate, 100 feet (30.5 meters), 32° 44′; spike on top of lighthouse, 219° 31′.3; right edge of office building, 1,000 feet (305 meters), 228° 08′.3; right edge of right chimney of left house, 1,100 feet (335 meters), 237° 19′.9; right edge of right chimney of right house, 1,200 feet (366 meters), 243° 06′.7. A secondary station for testing local disturbance was occupied 58 feet (17.7 meters) from *A* in direction of lighthouse.

B is in recreation-reserve, about 1½ miles (2.4 km.), north of township, 304.5 feet (92.81 meters) northwest of post which stands 155 feet (47.2 meters) west of main entrance to reserve, at west end of fence along south side of roadway and forming north side of some stock pens. True bearings: left edge of small iron shed on hill, one-fourth mile (0.4 km.), 74° 36′.9; right edge of tank of house, 600 feet (183 meters), 273° 47′.3; corner post at end of entrance, 304.5 feet (92.81 meters), 321° 21′; center spike on hall, 600 feet (183 meters), 337° 29′.1; bottom of left wireless mast, half mile (0.8 km.), 356° 23′.4.

Cutharra Pools, Western Australia, 1914.—About 50 yards (46 meters) from lower end of more westerly of two pools on Sturt Creek, native name for which is Cutharra.

Darwin, Northern Territory, 1914.—Exact reoccupation of station Port Darwin of 1912. In Botanical Gardens near north end of Mindil Beach, 55 feet (16.8 meters) northwest of center of road running southwest through avenue of coconut palms measured from point in road 62 feet (18.9 meters) southwest of intersection with center of roadway running southeast, 115 feet (35.1 meters) south of post on north side of latter roadway, and 104 feet (31.7 meters) north of northernmost coconut tree in row east of avenue; marked by drill-hole in top of concrete block 6 by 8 by 13 inches (15 by 20 by 33 cm.) sunk flush with ground and lettered on top C. I. W. 1912. True bearings: center of pile under house, looking along Coconut Avenue, about 1 mile (1.6 km.), 30° 35′.4; center spike on roof of house at Milly Point, 1 mile (1.6 kilometers), 36° 30′.8; rightmost white post of inclosure around above house, 37° 56′.2; post in north fence, 448 feet (136.6 meters), 178° 09′.6; nearest coconut tree, 350° 46′.

Delamere, Northern Territory, 1914.—In center of hard sandy flat northeast of Delamere cattle station, in paddock adjoining station-buildings and stock-yard. True bearings: near gable end of shed, 650 feet (198 meters), 45° 20′.9; left post of gateway, 500 feet (152 meters), 51° 34′.2; near gable end of station house, 800 feet (244 meters), 51° 50′.3; right post of gateway, 500 feet (152 meters), 52° 55′.5; end post of race of stockyard, 500 feet (152 meters), 128° 36′.4.

Depot, Northern Territory, 1914.—In landing reserve on south bank of Victoria River, about 100 yards (91 meters) west of landing, and 50 yards (46 meters)

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Depot, Northern Territory, 1914—continued.
from bank; marked by boxwood peg set just below ground and covered by a small cairn of sandstones. True bearings: blazed box-tree, 63.5 feet (19.35 meters), 82° 05′.0; tree on edge of bank, 67.5 feet (20.57 meters), 142° 49′.9; gum tree, 93 feet (28.3 meters), 260° 28′.9; near gable end of iron store, one-third mile (0.5 km.), 329° 01′.7; rightmost post of paddock, one-fifth mile (0.3 km.), 343° 16′.7.

Derby, Western Australia, 1914.—On flat open ground northeast of Derby Hotel, in line with front edge of northwest balcony of hotel, and in range with two white posts 8 feet (2.4 meters) high and about 500 feet (152 meters) apart, 352 feet (107.3 meters) southwest of nearer post, and about 450 feet (137.2 meters) from northeast corner of hotel balcony; marked by peg driven just below ground. True bearings: flag-pole on warehouse on Main Street, 600 feet (183 meters), 78° 37′.4; top of near range post, 236° 54′.4; right edge of water tank, about 1½ miles (2.4 kilometers), 309° 29′.8.

Dromedary Hill, Western Australia, 1914.—In camel reserve, 163 miles (262.3 km.) north of Burracoppin, about three-fourths mile (1.2 km.) south-southeast from Dromedary Hill, in line with south fence surrounding camelmen's hut, about 500 feet (152 meters) west-northwest from southwest corner of fence, and about 550 feet (168 meters) northeast of windmill and tank; marked by jarrah peg projecting slightly above ground. True bearings: right edge of tank at windmill, 65° 20′.7; trigonometric station on Dromedary Hill, three-fourths mile (1.2 km.), 155° 05′.0; right edge of hut near ground, 276° 36′.8.

East-West Railway Siding, South Australia, 1914.—On level ground about 600 feet (183 meters) east of East-West transcontinental railway, and northwest of siding known as 113½-Mile Siding; marked by cairn of stones 2 feet (61 cm.) high.

Eleven-Mile Dam, Western Australia, 1916.—Two stations, for determination of possible local disturbances, were established near Government Dam, 11 miles (17.7 km.) from Cranbrook on road leading eastward to Pallinup River. Station *A* is about 200 feet (61 meters) northeast of northeast corner of dam.

Station *B* is 360 feet (110 meters) east-northeast of station *A*, and bears approximately S. 245° 35′ W. (magnetic) from it. Both stations are marked by pegs 1.5 by 1.5 inches (4 by 4 cm.), left 2 inches (5 cm.) above ground.

Esperance, Western Australia, 1914.—On vacant land west of road between jetty and Israelite Bay, 165 feet (50.3 meters) northwest of survey peg, at point where road turns slightly northward, about 1 mile from jetty, 318 feet (96.9 meters) north-northeast of wooden fence which runs at right angles to the road; marked by jarrah peg set just below ground. True bearings: bottom of pole at radio station, 18° 12′.7; ornament on near gable of house, 69° 59′.8.

Etadunna, South Australia, 1914.—On a small stony knoll about 25 feet (8 meters) high, 600 feet (183 meters), north-northeast of homestead, and 250 feet (76 meters) east of mail-track to Hergott Springs; marked by cairn of stones 1.5 feet (46 cm.) high. True bearings: center shaft of far windmill, 700 feet (213 meters), 22° 52′.9; east gable of homestead, 25° 24′.1; west gable of homestead, 29° 13′.8; west corner post of fence, 900 feet (274 meters), 55° 12′.4; gable end of wool-shed, 1½ miles (2.4 km.), 55° 15′.1; east corner post of fence, 700 feet (213 meters), 335° 44′.6.

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Ethel Creek, Western Australia, 1914.—In home paddock north of Ethel Creek station, 16 feet (4.9 meters) south of north fence, measured from forty-seventh post from northwest corner of paddock; marked by peg driven just below ground. True bearings: left edge of chimney on hut, 400 feet (122 meters), 15° 09′.7; left edge of tank by windmill, 420 feet (128 meters), 324° 34′.1.

Eucla, Western Australia, 1914.—The station of 1911 was closely reoccupied in June and again in October 1914. On open ground east of settlement, 192 feet (58.5 meters) east of corner of fence opposite telegraph-offices and quarters, 203 feet (61.9 meters) southeast of southeast corner of concert hall, and about 1 foot (0.3 meter) south of point in range with east and west fence; station was not marked. True bearings obtained in October: gable end of shed near jetty, 18° 09′.0; telegraph-pole on street corner, 98° 54′.9; wind vane on telegraph-office, 107° 57′.2; flagpole on quarters, 122° 32′.8; gable end of hall, 137° 17′.6; right gable end of cottage, 188° 49′.9.

Farina, A, South Australia, 1914.—Exact occupation of station *A* of 1911, on small knoll in northeast corner of police paddock west of town, about 1 mile (1.6 km.) west of railway station, about 2,400 feet (732 meters) due west of Exchange Hotel, about 2,200 feet (671 meters) west-northwest of English church, 594 feet (181.1 meters) from east fence of paddock, and 637 feet (194.2 meters) from north fence; marked by jarrah peg set about 2 inches (5 cm.) under ground. True bearings: gable of pump-house, 230° 11′.0; west gable of public school, 279° 57′.0; west gable of English church, 288° 56′.4; west gable of red-roofed house, 1 mile (1.6 km.), 313° 13′.2.

Five-Mile Bar, Northern Territory, 1914.—On south bank of McArthur River, about 5 miles (8 kilometers) below Borroloola, about 1,000 feet (305 meters) east of bar of rocks known as Five-Mile Bar, about 400 feet (122 meters) west of west end of Whiskey Island, and about 70 feet (21 meters) south of edge of bank.

Flinders Island, Tasmania, 1914.—See White Mark, Tasmania.

Flora Valley, Western Australia, 1914.—On opposite side of creek from Flora Valley station and about one-third mile (0.5 km.) north of it, on high point of creek bank above water-hole, about 50 yards (46 meters) from edge of creek.

Fourteen-Mile Creek, Western Australia, 1914.—On north bank of Fourteen-Mile Creek, about 30 yards (27 meters) west of Alice Downs–Turkey Creek road, and 30 yards (27 meters) north of creek.

Fremantle, Western Australia, 1914.—See Rottnest Island.

Gawler, South Australia, 1915.—Near center of northern half of Gawler race-course, about 250 yards (229 meters) east of north side of grand-stand, approximately in line with its north end. True bearings: center of chimney-stack of Gilbert and Payne's old mill, 122° 00′.6; top of railway signal-post, 134° 06′.3; center of chimney-stack of Darling and Son's mill; north-northwest of railway station, 168° 03′.4; east wall of Church of Christ, at north end of race-course 169° 03′.1; high flagpole near east side of railway station, 171° 53′.4; center of chimney-stack of May Brothers' foundry, east of railway station, 178° 27′.4.

Gilbert's Well, South Australia, 1914.—On level open space in scrub, 800 feet (244 meters) west of Gilbert's Well at Kingoonyah, and 60 feet (18.3 meters) south of mail-track.

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Australia—*continued.*

Gladstone, Tasmania, 1914.—In north end of sports-ground reserve, in low scrub midway between north boundary fence and north goal-posts, 165 feet (50.3 meters) south-southwest from north corner of reserve and 152 feet (46.3 meters) east-southeast from west corner of reserve; marked by hardwood stake set just below ground. True bearings: near gable end of school, 500 feet (152 meters), 50° 27′.6; spike on near gable end of store, 450 feet (137 meters), 92° 35′.3; west corner of sports reserve, 100° 27′.6, right edge of right chimney of hotel, 500 feet (152 meters), 101° 06′.3; right gable-end of iron building, one-third mile (0.5 km.), 142° 49′.4; near gable end of large shed at Scotia mine, 2 miles (3 km.), 151° 36′.4; near gable-end of red-roofed cottage, 250 feet (76 meters), 181° 50′.5; north corner of sports-ground reserve, 194° 37′.9; left edge of sports pavilion, 600 feet (183 meters), 344° 20′.4.

Goodwin Soak, Western Australia, 1914.—On Canning stock route, on mulga flat above bed of lake, 260 paces north of near corner of dump at well No. 11, and 22 paces from northeast corner of small inclosure of limestone boulders. True bearing: bottom of fork at well, 1° 45′.2.

Goolwa, South Australia, 1918.—In public school reserve, about three-fourths mile (1.2 km.) north-northwest of Goolwa township, at a point north of schoolhouse and yard, near middle of reserve; marked by concrete circle, flush with ground, engraved Geodetic and Magnetic Survey of S. A., with cross arms pointing north-south, east-west, engraved ϕ 35° 30′.0S. λ 138° 46′.8E, with a meridian mark fixed 3 chains (60 meters) north of station. True bearings: cross on Wesleyan Church (left of two crosses in field of view of inverting telescope), 9° 03′.4; corner post of block, 8 chains 61¾ feet (179.76 meters), 128° 58′.4; northerly of two crown-posts of railway curve, 5 chains, 65 feet (120.39 meters), 129° 28′.5; southerly of two crown posts of railway curve, 5 chains 43¼ feet (113.77 meters), 130° 58′.3; highest point on Hindmarsh Island (old Trig. mound), 291° 55′.6.

Goyder River, Northern Territory, 1914.—On small open saline flat on left bank of Goyder River, about 7 miles (11 km.) from mouth of river, 141 feet (43.0 meters), southwest of edge of bank, and 66 feet (20.1 meters) south of scrub; marked by hardwood post projecting about 9 inches (23 cm.) above ground.

A secondary station was established at peg used as azimuth mark, 300 feet (91 meters) distant, to test for local disturbance.

Goyder's Lagoon, South Australia, 1914.—On level ground 500 feet (152 meters) north of homestead, 279.0 feet (85.04 meters) northwest of wire fence, and 10 feet (3.05 meters) east of ring of stones; marked by cairn of stones. True bearings: gable of galvanized-iron shed with white roof, 500 feet (152 meters), 2° 52′.0; left edge of left support of windlass barrel at well, 700 feet (213 meters), 34° 54′.8; east corner of cattle-yard, 300 feet (91 meters), 285° 40′.9; west corner of cattle-yard, 400 feet (122 meters), 306° 26′.2; near corner of stone chimney of homestead, 358° 42′.2.

Green's Well, Western Australia, 1917.—About 11 miles (18 kilometers) along Green's Road from point of junction with Dandarraga Road, 7.5 miles (12 km.) west of Moora, 237 feet (72.2 meters) southwest of center of Green's well and in line with drum-axis of windlass of well, and 112 feet (34 meters) from center of Green's Road; marked by a peg left 3 inches (8 cm.) above ground. True bearings: tree on hill, about

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Australia—*continued.*

Green's Well, Western Australia, 1917—continued.
half mile (0.8 km.), 43° 17′.1; center of end of drum on well, 218° 18′.6; top of prominent bare hill, about 1 mile (1.6 km.), 336° 00′.6.

Guli, Western Australia, 1914.—On Canning stock route, 156 feet (47.6 meters) northeast of north corner of railing around tank which is No. 42 water of stock route. True bearing: post at north corner of railing around tank, 36° 32′.

Haddon Downs, South Australia, 1914.—On small stony rise about one-fourth mile (0.4 km.) east of homestead, south of road to Cadelga, north of water-hole and east of small creek that empties into water-hole; marked by gidyea peg projecting 1 inch (2.5 cm.) above ground, covered by cairn of stones 18 inches (46 cm.) high. True bearings: north edge of stone chimney, 1,000 feet (305 meters), 92° 56′.0; gable end of shed adjoining homestead, 94° 29′.4; north corner of chimney of homestead, 96° 53′.1; strainer-post at angle of fence, 600 feet (183 meters), 99° 10′.0; near corner of small building, 1,000 feet (305 meters), 111° 59′.4; near post of grave, one-fourth mile (0.4 km.), 155° 54′.3.

Hall's Creek, Western Australia, 1914.—On slope about 220 feet (67 meters) from rear of post-office, and 310 feet (94.5 meters) from near corner of walls of institute. True bearings: near corner of institute, 310 feet (94.5 meters), 118° 50′.7; left edge of post-office chimney, 250 feet (76 meters), 180° 29′.2.

Hergott Springs, South Australia, 1914.—Close reoccupation of station of 1911, in an open tract south of railroad. True bearings: ornament on gable of Wilson's butcher shop, 250 feet (76 meters), 73° 41′.2; near corner of Great Northern Hotel, 350 feet (107 meters), 157° 51′.2; top of semaphore, 450 feet (137 meters), 213° 05′.0; near gable of engine running-sheds, 500 feet (152 meters), 246° 16′.4; top of semaphore, 1,200 feet (366 meters), 292° 25′.8.

Hobart, D. Tasmania, 1914.—In inclosure near rear entrance to Government House, 120 feet (36.6 meters) north of north face of old hexagonal observatory, and a few feet north of path leading across inclosure to house of private secretary. True bearings: center of hexagonal building, 127 feet (38.7 meters), 4° 35′; near gable end of house across river, 2 miles (3.2 km.), 193° 54′.5.

A secondary station for declination observations was located 44 feet (13.4 meters) nearer observatory on line from principal station to gable end of house across river.

Hopetoun, Western Australia, 1914.—On open land near seashore, and in front of Port Hotel and post-office, 64.4 feet (19.63 meters) west of narrow-gage railroad, about 240 feet (73 meters) east of wooden fence on west side of main street, and 93 feet (28.3 meters) northwest of telegraph-post on railway; marked by jarrah peg set just below ground. True bearings: beacon lamp on end of jetty, 16° 16′.4; top point of roof of post-office, 136° 48′.9; beacon on hill, 207° 38′.4; beacon on shore, 245° 18′.1.

Innamincka, South Australia, 1914.—Two stations, designated *1* and *2*, were established east of Cooper's Creek. Station *1* is north of village, on high ground 15 feet (4.6 meters) east from near edge of track, and 600 feet (183 meters) north of Innamincka Hotel; marked by circular pile of desert stones 2 feet (0.6 meter) high and 4 feet (1.2 meters) in diameter. True bearings: east edge of east chimney of hotel, 1° 16′.1; northwest corner of hotel, 6° 04′.5; west corner of

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Innamincka, South Australia, 1914—continued. store, 800 feet (244 meters), 11° 12′.0; top of west corner of old sheep-yard, 135.9 feet (41.42 meters), 159° 33′.9; top of east corner of old sheep-yard, 128.2 feet (39.08 meters), 185° 55′.1; trigonometric station, Innamincka Hill, 3 miles (4.8 km.), 229° 58′.9; center shaft of windmill, 650 feet (198 meters), 358° 44′.6.

Station *2* is one-fourth mile (0.4 km.) southwest of station *1*, on a small low sand-hill on river flat, about 1,000 feet (305 meters) due west of hotel, 300 feet (91 meters) east of Cooper's Creek, and 100 feet (30 meters) west of border between sandy flood plain and rocky desert; marked by eucalyptus peg projecting 3 inches (8 centimeters) above ground. True bearings: top of southeast corner post of old sheep-yard, one-fourth mile (0.4 km.), 227° 26′.6; station *1*, 231° 38′.1; northwest corner of hotel, 268° 06′.0; center shaft of windmill, 1,100 feet (335 meters), 276° 17′.5; eucalyptus tree marked with flood height, 69.3 feet (21.12 meters), 289° 22′.4; near corner of store, 800 feet (244 meters), 294° 03′.6.

Israelite Bay, Western Australia, 1914.—On rising ground about half mile (0.8 km.) north of jetty, 130 feet (39.6 meters) west of telegraph-line.

Kapunda, South Australia, 1915.—In Dutton Park, on drive entering from Baker Street, near south side of drive, in line with north face of southern gate-pillar at Baker Street entrance, 334.2 feet (101.86 meters) northwest of its inner edge. True bearings: wind-vane on Baptist church spire, 300° 54′.0; center ornament of entrance gate of park, 301° 04′.8; Church of England spire, 301° 56′.0; iron part of south standard of entrance gate, 302° 24′.8.

Karamara, Western Australia, 1916.—Seven stations were occupied. Base station *A* is about 5.5 miles (8.8 km.) west of Moora, in line with northern fence around government well, and 328 feet (100 meters) southwest of west corner of well inclosure. Upon a line through station *A* running approximately northwest to southeast, six auxiliary stations for determination of local disturbance were located at intervals of 120 feet (36.6 meters), those to northward being designated *2N*, *4N* and *6N* respectively, and those to the southward *2S*, *4S* and *6S* respectively. The true bearing of the line was not determined, its magnetic bearing being approximately 147° 40′. Station *A* and stations *6N* and *6S* at the extremities of the line are marked by pegs left 2 inches (5 cm.) above ground.

Karara Soaks, Western Australia, 1914.—On Canning stock route, about 60 paces east of No. 24 well.

Karla Spring, Western Australia, 1916.—See Warren's Flat and Tallering.

Katherine River, Northern Territory, 1914.—Exact reoccupation of station of 1912. In horse paddock of Katherine telegraph-station, 451.5 feet (137.62 meters) northeast of east corner of masonry tower supporting telegraph-wire, 438 feet (133.5 meters) south of left edge of wooden shed northwest of stockyard, and 98 feet (29.9 meters) north of gum tree; marked by wooden peg sunk just below surface. True bearings: bottom of right iron pole on tower near office, 451.5 feet (137.62 meters), 60° 57′.5; left edge of galvanized iron building, 250 feet (76 meters), 86° 06′.5; bottom of right iron pole in tower on far side of river, 1,000 feet (305 meters), 93° 56′.8; left edge of wooden shed, 183° 43′.7.

Kilagurra Springs, Western Australia, 1914.—See Water No. 17.

King Island, Tasmania, 1914.—See Currie.

King River, Northern Territory, 1914.—See Twenty-Mile Landing.

King's Park, Perth, Western Australia, 1914.—Reoccupation of station of 1912. See Perth.

Kingston, South Australia, 1917.—In bathing-reserve inclosure on foreshore, 290 feet (88.4 meters) south-southwest of center of harbor flagstaff, 32.7 feet (9.97 meters) west of nearest point of fence along road parallel to beach, and 76.1 feet (23.19 meters) west of fence on opposite side of same road; marked by a peg driven into ground. True bearings: tree top on highest point on Mount Benson, about 12 miles (19 km.), 33° 18′.6; top of lighthouse at end of jetty, 137° 15′.5; center of harbor flagstaff, 203° 21′.0.

Kookabubba Well, Western Australia, 1914.—Near dray track used by Mr. Canning to reach well No. 2 on stock route, about 30 feet (9.1 meters) north-northeast of Kookabubba well, and 100 feet (30.5 meters) south of dray track.

Kuduarra, Western Australia, 1914.—On Canning stock route, 151 feet (46.0 meters) from northwest corner of dump of well No. 46. True bearings: center of well, 244° 40′.

Kybybolite, 1917.—In Park Lands, about 150 yards (137 meters) southeast of railway station; marked by survey mark, a concrete circle flush with ground and engraved Geodetic and Magnetic Survey of S. A., with cross arms pointing north-south and east-west, engraved $\phi = 36° 53' 12''$ S, $\lambda = 140° 55' 30''$E. True bearings: survey peg near corner of road across railway culvert, 154 meters, 33° 04′.1; crown-post of railway curve, 128 meters, 72° 07′.9; gable of building to left of Experimental Farmhouse, 344° 04′.3; northeast wall of Experimental Farmhouse, 345° 02′.1. A meridian mark, consisting of a cement block, is fixed 3 chains (60.4 meters) north.

Lake Miranda, Western Australia, 1914.—About 100 feet (30 meters) west of telegraph-line near southern end of Lake Miranda, and 25 miles (40 km.) northwest of Lawlers.

Latrobe, Tasmania, 1915.—In neighborhood of Tasmanian Magnetic Survey station in western part of racecourse reserve, on north side of road to Deloraine, 18.5 feet (5.64 meters) east of west fence, and 389.2 feet (118.62 meters) north of south fence. True bearings: left edge of right chimney of new house, one-third mile (0.5 km.), 0° 36′.6; right edge of rock on Mount Roland, 17.5 miles (28.2 km.), 30° 05′.9; spike on front of near gable of house, 1,500 feet (457 meters), 76° 11′.8; near gable end of building on hillside, 1 mile (1.6 km.), 103° 29′.6; right edge of right chimney of house, one-third mile (0.5 km.), 157° 32′.2.

Lawlers, Western Australia, 1914.—Exact reoccupation of station of 1912. In recreation-ground reserve, 82 feet (25.0 meters) from north fence and 112 feet (34.1 meters) from west fence; marked by short jarrah peg set flush with ground. True bearings: southwest corner of recreation-reserve, 650 feet (198 meters), 10° 37′; top of mine chimney visible on skyline, 254° 26′.9; right end of roof ridge Commercial Hotel, one-half mile (0.8 km.), 258° 26′.9.

Leonora, Western Australia, 1914.—At a camel camp about 4 miles (6.4 km.) northwest from Leonora on Gorge or Four-Mile Creek, between Leonora and Lawlers, and about one-fourth mile (0.4 km.) up creek from Four-Mile Well. True bearing: left edge of leftmost

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AUSTRALIA—*continued.*

Leonora, Western Australia, 1914—continued. tank of Leonora water-supply tanks on St. George Hill, 3 miles (4.8 km.), 165° 24′.6.

Liverpool River, Northern Territory, 1914.—See Cadell's Landing.

Logan Well, Western Australia, 1914.—About 150 feet (46 meters) west of telegraph-line, on road between Lawlers and Wiluna, about 58 miles (93.4 km.) from Lawlers, and two-thirds mile (1.1 km.) south of Logan Well.

Long Gully, South Australia, 1917.—On coast about 18 miles (29 km.) by road south of Robe, on a jutting ledge of rock, on north side of cove at termination of Long Gully; marked by an aluminum peg drinve into ground and covered by a small pile of stones, a broad arrow being cut into exposed surface of flat limestone rock, point of arrow being 15.9 feet (4.85 meters) west of peg. True bearings: highest point of prominent isolated rock, about one-fourth mile (0.4 km.), 144° 09′.7; square edge of cliff, about 200 or 300 yards (0.25 km.), 358° 13′.2.

Lungan Pool, Western Australia, 1914.—Near a pool on one of the branches of Sturt Creek, about 8 miles (13 km.) north of Guda Soak, and half mile (0.8 km.) south of Lungan Pool.

McArthur River, Northern Territory, 1914.—See Five-Mile Bar, and Black Rocks, Northern Territory.

McArthur's Well, South Australia, 1914.—On level ground about 300 feet (91 meters) north-northeast of McArthur's Well at Coondambo, and north of mail-track between Port Augusta and Tarcoola; marked by inverted bottle buried 3 inches (8 cm.) below ground. True bearing: bottom of west support of windlass of well, 27°.3.

Madura, Western Australia, 1914.—In midst of ruined buildings of a former station, in line with southeast fence of garden in rear of dwelling, and 133 feet (40.5 meters) northeast of east corner of same fence; marked by jarrah peg set just below ground. True bearing: left edge of chimney on house, 89° 41′.0.

Mallabie Tanks, South Australia, 1914.—On level ground about 40 feet (12 meters) south of mail-track, 165 feet (50.3 meters) west of tank-shed, and about 206 feet (63 meters) south of telegraph-line; marked by inverted bottle set level with ground. True bearings: topmost northwest corner of tank-shed, 180 feet (54.9 meters), 261° 59′.8; near post of shed, 165 feet (50.3 meters), 266° 55′.6; topmost southeast corner of shed, 200 feet (61.0 meters), 267° 36′.1.

Managum Well, Western Australia, 1917.—Three stations, designated *A*, *B*, and *C*, were occupied, south of paddock around well. Station *A* is 58.5 feet (17.8 meters) south of southern fence of paddock, measured from a point 174 feet (53 meters) along fence from southwestern corner post; marked by a round stake left 6 inches (15 centimeters) above surface. True bearings: station *C*, 29° 55′.7; southwestern corner post of reserve, 109° 03′.4; center rod of windmill, about 310 feet (94 meters), 195° 42′.3; tree near gate of paddock, about 700 feet (213 meters), 232° 36′.5; station *B*, 330° 27′.2.

Stations *B* and *C* are about 450 feet (137 meters) southeast and southwest, respectively, from station *A*, and about same distance from each other.

Marble Bar, Western Australia, 1914.—About 120 feet (37 meters) northeast of road from Marble Bar to Coongan, about 12 feet (3.7 meters) south-southwest of a rocky bank about 16 feet (5 meters) high, and about 1,000 feet (305 meters) northeast of residence; marked by tent-peg driven flush with ground. True bearings: top righthand corner of large tank by railway, about one-fourth mile (0.4 km.), 12° 47′.2; right gable end of hut, about one-fourth mile (0.4 km.), 114° 19′.4; tip of telegraph-pole, about 1,200 feet (366 meters), 299° 58′.9.

Marble Well, South Australia, 1914.—On east side of Oongudinna Water-Hole in Oongudinna Creek, about 40 yards (37 meters) from bank and 150 yards (137 meters) north of well. True bearings: center of Marble Well, 13° 34′.5; center of big gum tree on edge of water-hole, 31° 58′.7; center of big gum tree on edge of water-hole, 161° 29′.8.

Marchagee, Western Australia, 1916.—Four stations designated *A*, *B*, *C*, and *D*, were occupied, about 4 miles (6 km.) southwest of Mr. E. W. Paton's farm-house, about 800 feet (244 meters) southwest of a prominent hill upon which were a few low trees and bushes, and just west of a group of clay-pans. Each station was marked by a peg projecting slightly above ground. True bearings from station *A*: highest point on prominent hill, 230° 08′.0; large bright rock, about 3 miles (5 km.), 298° 09′.3; tree-trunk on horizon, about 3 miles (5 km.), 302° 26′.9. Stations *B*, *C*, and *D* with station *A* are at the angles of a rectangle about 630 by 805 feet (192 by 245 meters). Station *B* bears south 1° 51′ east from *A* and is distant about 805 feet (245 meters). Station *C* bears north 88° 14′.4 east from *B*, distant about 630 feet (192 meters), and is approximately due south 805 feet (245 meters) from station *D*. Station *D* bears north 88° 06′.4 east of station *A* and is distant about 630 feet (192 meters).

Marra, Western Australia, 1914.—In the paddock of Mr. Gordon Moir's station on Pallinup River, about 8 miles (13 km.) from the coast, 232 feet (70.71 meters) southwest from southwest corner post of fence inclosing house, about 600 feet (183 meters) east-southeast of larger barn, and 40 feet (12.2 meters) north of a curious five-limbed tree; marked by jarrah peg set just below ground. True bearings: right gable end of highest barn, 95° 49′.4; tip of ornament on gable end of house, 219° 32′.0.

Meekatharra, Western Australia, 1914.—Almost exact reoccupation of station of April 1912, though marking peg could not be found; within recreation-ground, near northwest corner, 97 feet (29.6 meters) south of north fence, 121 feet (36.9 meters) east of west fence; marked by tent peg driven flush with ground. True bearings: near gable end of shed in recreation-ground, 9° 27′.7; survey peg at northwest corner of ground, 149° 55′.7; water-gage on tank at Luke trigonometric station, 271° 11′.9; cross on left gable end of Catholic church, 322° 31′.5.

Melbourne, Victoria, 1914, 1916.—In 1914 comparison observations were made on *Dip-Circle Pier* in absolute house of Melbourne Observatory and at station *B*. Station *B* is exact reoccupation of C. I. W. station *B* of 1911, 1913, and 1914, on lawn in front of main building of Melbourne Observatory, midway between main gate and office, and is approximately the same as that occupied by Austrian Naval Expedition, 23 feet (7 meters) northwest of edge of main walk; marked by drill-hole in top of sandstone block about 6 inches (15 cm.) square, sunk 2 inches (5 cm.) in ground and marked C. I. W. 1911. True bearing: white line on wooden building, about 260 feet (79 meters), 318° 59′.4.

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AUSTRALIA—*continued.*

Melrose, South Australia, 1916.—Near center of Dorrington Park, formerly used as a recreation oval, about 500 yards (457 meters) west of railway station, and 620.7 feet (189.18 meters) southwest of peg north of railway culvert; marked by survey reference-mark of cement, flush with ground, and inscribed Geodetic and Magnetic Survey of S. A., on outer circle, and $\lambda=138° 11'.5$, $\phi=32° 38'.4$ on cross arms. True bearings: highest tree on Mount Remarkable, 98° 50′.9; peg north of culvert, 224° 56′.3; south end of stonework of culvert, 237° 36′.8; north end of iron bridge over creek, 261° 08′.7; south end of iron bridge over creek, 265° 48′.9.

Melville Island, Northern Territory, 1914.—See Brenton Bay and Piper Head.

Merredin, Western Australia, 1916.—Two stations were occupied, designated *A* and *B*. Station *A* is exact reoccupation of station of 1912, south of Merredin Peak, 137 feet (41.8 meters) northwest of northwest corner of wire fence surrounding railway dam; marked by a jarrah peg 2 by 2 inches (5 by 5 cm.), left slightly below surface of ground. True bearings: center of triangulation cairn on top of a granite hill, 196° 12′.2; right post supporting a water-gate, 213° 51.′7; northwest corner post of wire fence around dam, 320° 53′.2.

Station *B* is 336.5 feet (102.56 meters) southwest of station *A*; marked by a peg 3 by 3 inches (8 by 8 cm.), sunk almost level with surface of ground. True bearings: center of triangulation cairn on a granite hill, 1 mile (1.6 km.), 199° 36′.5; station *A*, 232° 44′.6.

Miranda, South Australia, 1914.—On a level stretch of ground north of water-hole, 70 feet (21 meters) west of a small creek which empties into water-hole, and 200 feet (61 meters) east of a low sand-hill which is encroaching on homestead; marked by peg projecting 6 inches (15 centimeters) above ground. True bearing: north corner of small square stone building, 600 feet (183 meters), 30° 15′.0.

Mirra-Mitta Bore, South Australia, 1914.—On level sandy soil, about 700 feet (213 meters) west-southwest of bore; marked by small cairn of stones. True bearings: north corner post of yard, 650 feet (198 meters), 248° 23′.9; center of bore, 680 feet (207 meters), 254° 42′.9; north top corner galvanized-iron shed, 600 feet (183 meters), 288° 25′.5; north gable of galvanized-iron house behind store, 700 feet (213 meters), 292° 05′.4; south gable of galvanized-iron house behind store, 700 feet (213 meters), 294° 14′.6; south corner post of yard, 800 feet (244 meters), 306° 40′.2.

Mission Station (Bathurst Island), Northern Territory, 1914.—At south end of avenue of trees about midway between south end of lagoon and edge of shore, and 58 feet (17.7 meters) southeast of southernmost tree of avenue; marked by stake set flush with ground. True bearings: near gable end of church, 800 feet (244 meters), 14° 09′.1; left gable end of mission dormitory, 19° 21′.7; near gable end of kitchen, 800 feet (244 meters), 22° 44′.0; right gable end of mission school, 800 feet (244 meters), 42° 35′.6; left gable of westernmost cottage, 800 feet (244 meters), 86° 08′.9; near gable end of building behind priest's house, 650 feet (198 meters), 134° 51′.9; right gable end of Cooper's house on Melville Island, one-fourth mile (0.4 km.), 219° 51′.7; east corner post of mission fence, 650 feet (198 meters), 358° 55′.5.

Mission Station (Roper River), Northern Territory, 1914.—On north bank of Roper River, in open paddock adjoining mission gardens and stock paddock, north-northwest of mission house, and 66 feet (20.1 meters) east of large lone tree; marked by drill-hole in top of

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Mission Station (Roper River), Northern Territory, 1914—continued.
round stake driven flush with ground. True bearings: northwest corner post of garden fence, 181 feet (55.2 meters), 31° 45′.4; lone tree, 105° 05′; north end of Mt. Olive, 3 miles (4.8 km.), 241° 30′.5; south edge of range, 2 miles (3.2 km.), 290° 27′.8; left edge of tank, 800 feet (244 meters), 352° 19′.6; spike on front gable of natives' kitchen, 700 feet (213 meters), 359° 55′.6.

Montgomery Islands, Western Australia, 1914.—Near center and highest point of one of islands of Montgomery group known locally as Washington Island since the establishment of magnetic station; marked by cairn of stones 3 feet (0.9 meter) high. True bearing: prominent rock on adjacent island, fourth south of mainland, 1 mile (1.6 km.), 256° 50′.0.

Moola Bulla, Western Australia, 1914.—Near the aboriginal station, 303 feet (92.4 meters) southeast of southeast corner of fence around manager's house, and 203 feet (61.9 meters) northeast of nearest point of southwest fence of house paddock; marked by gum peg sunk just below ground. True bearings: near corner of fence around house, 140° 20′.6; near gable end of store, 1,000 feet (305 meters), 144° 57′.1; left edge of reservoir, at bottom, 1,200 feet (366 meters), 170° 48′.2; south corner of house-paddock fence, 1,500 feet (457 meters), 338° 32′.2.

Moora, Western Australia, 1914.—Exact reoccupation of station of 1912, in recreation-grounds, 297.5 feet (90.68 meters) from west fence, and 373.5 feet (113.84 meters) from southwest corner of grounds; marked by jarrah peg set below surface. True bearings: survey post in southwest corner of grounds, 42° 42′.7, survey post in northwest corner of grounds, 400 feet (121.9 meters), 135° 14′.2; right gable end of large shed in show grounds, 800 feet (244 meters), 325° 45′.4.

Moorilyanna, South Australia, 1914.—The main station is at southwest foot of Moorilyanna Hills, 90 yards (82 meters) southeast of native soakage-well, and 54 feet (16.5 meters) and 95 feet (29.0 meters) respectively southeast and southwest from granite outcrops; marked by bottle sunk just below ground and containing inscription: "Moorilyanna magnetic station Sept. 1914," and covered by small heap of granite rocks. True bearings: Mt. Illbillee (Everard Ranges), 25 miles (40 km.), 71° 03′.5; highest granite knob on nearer western hills, 1 to 2 miles (1.6 to 3.2 km.), 86° 24′.8; Moorilyanna trigonometric station, 222° 27′.8.

A secondary station was established 604 yards (552.3 meters) from main station, in azimuth 35° 26′, on gently rising ground appearing from main station as a clear patch in surrounding scrub; marked by small pile of rocks.

Mount Gason Bore, South Australia, 1914.—On a small bare shallow depression 800 feet (244 meters) east-northeast of homestead, and 700 feet (213 meters) southeast of outlet of bore-pipe; marked by small pile of stones. True bearings: trigonometric station, Mount Gason, 5 miles (8 km.), 35° 39′.2; gable of white galvanized-iron shed at homestead, 650 feet (198 meters), 75° 27′.0; hurricane lamp near bore, 520 feet (158 meters), 76° 15′.7; pile of stones on hill, 2 miles (3.2 km.), 116° 19′.5; outlet of water from bore, 700 feet (213 meters), 132° 57′.2; trigonometric station on hill, 2 miles (3.2 km.), 235° 32′.3; east corner post of goat-yard 600 feet (183 meters), 357° 11′.5.

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Mount Hopeless Bore, South Australia, 1914.—On level ground, 900 feet (274 meters) west of out-station, and 89.2 feet (27.19 meters) southwest of wire fence, measured from a point 245.0 feet (74.67 meters) east-southeast from east post of gate at mail-track to Innamincka; marked by inverted glass bottle buried 2 inches (5 cm.) below ground. True bearings: Mount Hopeless trigonometric station, 10 miles (16 km.), 20° 51′.7; near corner of small yard, 243.2 feet (74.13 meters), 38° 27′.9; corner post of paddock, 1,200 feet (366 meters), 120° 45′.4; inside of east gate-post on mail-track, 250 feet (76.2 meters), 134° 55′.1; near corner of house, 900 feet (274 meters), 272° 08′.2; top of windmill, 900 feet (274 meters), 274° 57′.9; center of turnstile on east side of creek, 350 feet (106.7 meters), 281° 36′.3.

Mount Lyndhurst, South Australia, 1914.—On rocky knoll, 15 feet (4.6 meters) above road level, 120 feet (37 meters) north of mail-track to Innamincka, 392 feet (119.5 meters) west of wire fence, and 2 miles (3.2 km.) west of Mount Lyndhurst wool-shed; marked by upturned bottle buried 2 inches (5 cm.) below ground and covered by cairn of white quartz stones 1 foot (30 cm.) high. True bearings: small scarp on range, 5 miles (8 km.), 98° 08′.4; broken bottle glass on top of knoll, 36.2 feet (11.03 meters), 241° 27′.4; southernmost finial on wool-shed, 2 miles (3.2 km.), 273° 14′.0; south side of north gate-post, 392 feet (119.5 meters), 284° 17′.4; north side of south gate-post, 392 feet (119.5 meters), 285° 36′.0; center of small red flint stone on top of knoll, 220 feet (67.1 meters), 326° 39′.2; trigonometric station on hill, 4 miles (6.4 km.), 352° 17′.4.

Mount Ruskin, 1918.—On highest point of Mount Ruskin, 10 feet (3 meters) west of old Trigonometrical Survey pile; marked by concrete circle flush with ground, engraved Geodetic and Magnetic Survey of S. A., with cross arms pointing north-south and east-west, engraved $\phi = 38° 2' 58''$, $\lambda = 140° 57' 49''.5$. True bearings: Cape Northumberland Lighthouse, 87° 37′.1; highest point of Mount Schank (south), 120° 00′.3; highest point of Mount Schank (north) 120° 59′.4; highest point of Mount Gambier west of Centennial Tower, 141° 10′.2; Centennial Tower on Mount Gambier, 141° 12′.8; gable of Mr. J. Holloway's house, half mile (0.8 km.), 235° 07′.3. A meridian mark was fixed 4 chains north of station.

Mullewa, Western Australia, 1916.—Three stations were occupied, about one-fourth mile (0.4 km.) northeast of railway station, in open space between schoolhouse and Dalgety's stock-yards. Station *A* is about 190 feet (58 meters) southwest of southwest corner post of stock-yard surrounded by board fence; marked by a wooden tent peg, projecting 2 inches (5 centimeters) above ground. True bearings: windmill in Dalgety's stock-yards, 197° 08′.4; southwest corner post of stock-yard, 209° 17′.4; east cross on a Catholic building, 314° 40′.8.

Station *B* is about 540 feet (165 meters) south 33° 58′.0 east of station *A*; marked by a wooden tent-peg, projecting 2 inches (5 centimeters) above ground.

Station *C* is about 540 feet (165 meters) south 26° 00′.1 west of station *A*, and about same distance west of station *B*; marked by a wooden tent-peg, projecting 2 inches (5 cm.) above ground.

Mundawindi, Western Australia, 1914.—On cleared land about 500 feet (152 meters) north of old telegraph-station, and about 500 feet (152 meters) east of new telegraph-station.

Murnpeowie, South Australia, 1914.—On a small hill 400 feet (122 meters) east of homestead, in range with middle veranda post of east side of homestead and east chimney of engineer's house, and 84.8 feet (25.85 meters) east of wire fence measured from a point 211 feet (64.31 meters) north of gate; marked by stringy-bark peg projecting 2 inches (5 cm.) above ground. True bearings: cairn on low hill, 2 miles (3.2 km.), 13° 28′.8; south side of south chimney of homestead, 55° 04′.9; south inside edge of second window from north of homestead, 57° 17′.1; base of belfry on store, 500 feet (152 meters), 83° 43′.2; near corner of store chimney, 500 feet (152 meters), 87° 12′.9; gable end of wool-shed, 800 feet (244 meters), 97° 02′.6; top of old windmill shaft, one-third mile (0.5 km.), 160° 02′.3.

Murray Bridge, South Australia, 1914.—Close reoccupation of station of 1911, though considerable building has been done in neighborhood and cricket-pitch of brick and concrete has been put down; the inner edge of timber around the cricket-pitch is distant 13.5 feet (4.11 meters); bolt in timber at northwest corner of pitch, 20.8 feet (6.34 meters). True bearings: gable end of house, 750 feet (229 meters), 4° 20′.9; bottom left edge of small pavilion, 235 feet (71.6 meters), 86° 27′.5; top left edge of chimney of "Quorna" house, 300 feet (91 meters), 124° 07′.9; cross on church, 900 feet (274 meters), 182° 40′.5; left edge of left support of left water-supply tank, one-fourth mile (0.4 km.), 247° 24′.9; finial spike on house, 1,000 feet (305 meters), 277° 03′.6.

Murta Murta Well, South Australia, 1914.—On flat top of a sand-hill south of Innamincka mail-track and about 350 feet (107 meters) south of homestead. True bearings: west corner post of goat-yard, 228.9 feet (69.77 meters), 163° 21′.7; gable end of galvanized-iron house, 350 feet (107 meters), 187° 18′.2; east corner post of goat-yard, 199.2 feet (60.72 meters), 210° 30′.4; notch on tree, 53.9 feet (16.43 meters), 220° 14′.0; hurricane lamp on tree, 250 feet (76 meters), 224° 59′.2; far windmill, 1,000 feet (305 meters), 227° 11′.5.

Musgrave Range, South Australia, 1914.—Observations of declination were made with a compass along route of an expedition in the Musgrave Range, at 20 points between south latitude 26° 54′ and 28° 12′, and east longitude 133° 06′ and 135° 24′. In Table of Results only mean position and mean resulting declination is given. See more extended account under Report of Government Astronomer G. F. Dodwell, page 152.

Nairne, South Australia, 1918.—In Mt. Lofty ranges, in northeast corner of quarry reserve on hill southeast of Nairne railway station and 13.13 chains (264.11 meters) south of center of main railway crossing; marked by survey mark consisting of concrete circle, flush with ground, engraved Geodetic and Magnetic Survey of S. A., with cross arms pointing north-south, east-west, engraved ϕ 35° 02′.4S, λ 138° 54′.4E, with a meridian mark fixed 1 chain (20 meters) south. True bearings: center of warning post on west side of railway crossing, 192° 55′.8; center of warning post on east side of railway crossing, 197° 55′.8; spike on gable of house used as Nairne Hospital, near railway crossing, 197° 56′.9; ornament on gable on west side of house on slope of hill, three-fourths mile (1.2 km.), 272° 21′.1; rod on northeast gable of church, one-fourth mile (0.4 km.), 279° 59′.4.

Nappacoongie Well, South Australia, 1914.—On a low irregular sand-hill, 100 feet (30.5 meters) east-south-

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Nappacoongie Well, South Australia, 1914—continued. east from Innamincka mail-track, and 390 feet (119 meters) northeast of well; marked by mallee peg projecting 6 inches (15 cm.) above ground. True bearings: bottom left edge of left leg of windlass support, 391.4 feet (119.30 meters), 40° 24′.6; bottom right edge of right leg of windlass support, 390 feet (118.9 meters), 41° 13′.3.

Naracoorte, South Australia, 1916.—On Agricultural show-grounds, 5.9 feet (1.80 meters) northeast of north end of cricket-pitch in middle of oval, and 61 yards (56 meters) from entrance to oval towards big gum tree to east. True bearing: spire of Presbyterian church, 41° 21′.7.

Nealyon's Rock-Hole, South Australia, 1914.—On small flat surface of bare clay about 100 feet (31 meters) south of track leading eastward to No. 7 bore, the rock-hole being north of track in a limestone catchment 300 feet (91 meters) long by 150 feet (46 meters) wide; marked by three large blocks of limestone set up in pyramid over a small peg of stringy-bark.

Nilpinna, South Australia, 1914.—East of Nilpinna Homestead, and 16 chains 53¼ links (332.58 meters) east-southeast of survey-post which is 4 yards (3.66 meters) southeast of center of spring; marked by post with brass plate inscribed: C. I. Magnetic Station Nilpinna. Long. 135° 41′ 49″ E. Lat. 28° 13′ 06″ S. Magnetic Variation 4° 06′ E. Nov. 3rd, 1914. True bearings: northeast wall of galvanized-iron hut, 26° 38′.8; center of south chimney on homestead, 81° 36′.4; center of north chimney of homestead, 87° 53′.5; survey-post near spring, 101° 30′.1.

Norseman, Western Australia, 1914.—Almost exact re-occupation of station of 1912, about 825 feet (251 meters) southeast of shore of Lake Cowan, near center of square reserved for warden's quarters, about 313 feet (95 meters) south of north boundary of square, about 424 feet (129 meters) from peg marking northeast corner, and nearly in line of fence on south of abandoned quarters; marked by jarrah peg driven flush with ground. True bearings: taller chimney of Mararoa Mine, 267° 56′.2; left edge of water-tank in town, 282° 28′.8.

Nullagine, Western Australia, 1914.—About one-third mile (0.5 km.) northeast of Conglomerate Hotel, 80 feet (24.4 meters) north of road to Marble Bar at top of first rise: marked by tent peg driven flush with ground. True bearings: left edge of tank by store, about half mile (0.8 km.), 38° 00′.9; right post of porch of warden's court, 1 mile (1.6 km.), 42° 31′.9.

Oatlands, Tasmania, 1914.—The station of Tasmanian Magnetic Survey, 27.1 feet (8.26 meters) south 2° 30′ west of station mark of same survey. True bearings: church spire, 80° 32′.2. Azimuth observations were made over the magnetic-station mark, which is a cylinder of Muntz metal set in solid rock on south shore of Lake Dulverton, near one of the largest caves on that shore, on property of Mr. Weeding, 13.5 feet (4.1 meters) southeast of edge of bank, north-east of unusually large she-oak tree, and in line with fence crossing east end of lake. True bearings: magnetic station, 2° 30′; center of front doorway of cottage on brow of hill, 1½ miles (2.4 km.), 63° 05′.7; church spire, three-fourths mile (1.2 km.), 80° 10′.0; left edge of Table Mountain, 109° 38′.6; near corner of left chimney of house, half mile (0.8 km.), 138° 37′.5; center of near gable of house, one-fourth mile (0.4 km.), 200° 30′.5.

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Oenpelli, Northern Territory, 1914.—In home paddock, about 450 feet (137 meters) north of Oenpelli Homestead, 111 feet (33.8 meters) west of east fence of paddock, 80.5 feet (24.5 meters) north 37° 50′ west of prominent tree, 372 feet (113.4 meters) north of south-east post of paddock; marked by copper rivet in top of ironwood stake set just below ground. True bearings: near gable end of station-house, 1° 28′.2; southeast corner post of home paddock, 3° 24′.3; bottom of left side of kitchen, 4° 05′.9; near gable end of kitchen, 4° 43′.7; near gable end of large bark shed, 9° 09′.7; trigonometric station on distant hill, about 2 miles (3.2 km.), 48° 33′.4; center veranda post of bark house, 400 feet (122 meters), 105° 35′.2; northeast corner post of home paddock, 400 feet (122 meters), 215° 01′.1.

A secondary station was established 100 paces north of station and in line with magnetic station and bottom of left side of kitchen, to test for local disturbance.

Ooldea Bore, South Australia, 1914.—On low sandy ground north of survey-line of East-West (transcontinental) Railway, 450 feet (137 meters) north of bore; marked by mallee peg projecting 6 inches (15 cm.) above ground. True bearing: hurricane lamp on north-west corner post of old shed, near bore, 420 feet (128 meters), 359° 09′.2.

Oongudinna Water-Hole, South Australia, 1914.—See Marble Well.

Ooroowilanie Reservoir, South Australia, 1914.—On level ground about 600 feet (183 meters) south of Ooroowilanie dam, 52.2 feet (15.91 meters) west of wire fence, and about same distance east of a sand-hill. True bearings: arrow-head cut on tree, 71.8 feet (21.88 meters), 115° 01′.6; center of west gable of homestead, 700 feet (213 meters), 188° 07′.3; east corner of homestead, 700 feet (213 meters), 190° 11′.4; corner post of fence, 1,000 feet (305 meters), 221° 12′.8; tree at corner of fence, 300 feet (91 meters), 358° 26′.9.

Patchawarra Well, South Australia, 1914.—Two stations, designated *1* and *2*, were occupied south of Patchawarra Creek. Station *1* is on barren clay flat, south-west of well and east of mail-track to Cordillo Downs. True bearing: hurricane lamp on small dump near bore, 400 feet (122 meters), 222° 09′.2.

Station *2* is on south bank of small shallow creek about 15 feet (4.6 meters) wide, 1,600 feet (488 meters) south of Patchawarra Creek, 120 feet (36.6 meters) northwest of center of mail-track and 45 feet (13.7 meters) from center of shallow creek-bed; marked by stringy-bark peg projecting 2 inches (5 cm.) above ground. True bearings: center of bore-shaft, 1,300 feet (396 meters), 219° 36′.9; hurricane lamp on dump near bore, 1,200 feet (366 meters), 221° 01′.9; tree stump marked with triangle chopped on, 83.8 feet (25.54 meters), 249° 47′.6.

Peak Hill, Western Australia, 1914.—Northeast of town, in northeast corner of recreation-reserve, 199 feet (60.6 meters) west-northwest from twenty-second post in east fence, and 192 feet (58.5 meters) south-southwest from eighteenth post in north fence, beginning the count with corner post in each case; marked by jarrah peg set just below ground. True bearings: base of trigonometric post on Peak Hill, half mile (0.8 km.), 35° 06′.3; chimney on state battery, 2 miles (3.2 km.), 167° 19′.1; left chimney of Peak Hill battery, 1½ miles (2.4 km.), 277° 09′.1.

Pellew Islands, Northern Territory, 1914.—See Sir Edward Pellew Islands.

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Penola, 1916.—In northeast corner of police grounds, east of police buildings, 1 chain (20 meters) south of meridian mark; marked by survey mark, a concrete circle flush with ground, engraved Geodetic and Magnetic Survey of S. A., with cross arms pointing north-south and east-west, also engraved ϕ 37° 22′ 35″, λ 140° 50′ 07″.7. True bearing: east edge of tower of Anglican church, 195° 34′.4.

Perth, Western Australia, 1914, 1916.—Station of 1912 was exactly reoccupied in 1914, and closely reoccupied in 1916. In bush on highest portion of King's Park, a short distance west of drive on east side overlooking Swan River, about 1 mile (1.6 km.) southwest of the transit circle of observatory, and is standard position of Survey Department for correcting compasses.

Pijallinga Claypan, Western Australia, 1914.—On camel-pad of Canning stock route, near patch of gum trees, about 200 yards (183 meters) south of claypan.

Pindar, Western Australia, 1916.—This locality was examined with reference to availability as a site for an observatory. Seven stations were occupied. Stations *A*, *B*, *C*, and *D* are on north side of road leading to Mullewa, in neighborhood of Peeraju Well, locally known as "the dog hole." Station *A* is in southwest corner of government reserve 1019, about 1,670 feet (509 meters) north-northwest of well; marked by a rough peg 3 inches (8 cm.) in diameter, projecting 4 inches (10 cm.) above ground. True bearings: tree on horizon, about 4 miles (6 km.), 183° 11′.9; Peeraju Well, 344° 46′.0. Station *B* is about 751 feet (228.9 meters) north, 26° 49′.6 west of station *A*; marked by a rough peg 2 inches (5 cm.) in diameter, projecting 2 inches (5 cm.) above ground. True bearings: tree-trunk on horizon, about 1 mile (1.6 km.), 274° 58′.0; station *A*, 333° 10′.4. Station *C* is about 730 feet (222.5 meters) west of station *A*; marked by a rough peg 3 inches (8 cm.) in diameter, projecting about 4 inches (10 cm.) above ground. True bearings: station *A*, 270° 02′.3; lowest part of upright post supporting lever at well, 323° 55′.9; space between pair of twin trees on horizon, about 3.5 miles (5.6 km.), 325° 46′.2. Station *D* is about 946 feet (288.3 meters) north 7° 02′.6 west of station *C*, and about 575 feet (175.3 meters) northwest of station *B*; marked by a rough peg 2 inches (5 cm.) in diameter, projecting 2 inches (5 cm.) above ground. True bearings: tree-trunk on horizon, about 1.5 miles (2.4 km.), 25° 29′.6; station *B*, 295° 47′.9; station *C*, 352° 57′.4.

Station *E* is about 1 mile (1.6 km.) south of Pindar railway station, 81 feet (24.7 meters) east of center of little-used road leading south from crossing west of station, and about 300 paces south of an outcrop of reddish sandstone with numerous rounded ironstone pebbles scattered over surface; marked by a rough wooden peg 2 inches (5 cm.) in diameter, projecting about 3 inches (8 cm.) above ground. Station *F* is about 727 feet (221.6 meters) south of station *E*, and about 77.8 feet (23.71 meters) west of middle of road leading south from railway station; marked by a rough peg 3 inches (8 cm.) in diameter, projecting 6 inches (15 cm.) above ground. True bearings: tree on horizon, 5 miles (8 km.), 134° 52′.0; station *E*, 178° 05′.7. Station *G* is about 738 feet (225 meters) southwest of station *E*, and about 724 feet (221 meters) northwest of station *F*; marked by a rough peg 2 inches (5 cm.) in diameter, projecting 3 inches (8 cm.) above ground. True bearings: tree-trunk on horizon, about half mile (0.8 km.), 41° 45′.0; station *E*, 238° 06′.3; station *F*, 297° 06′.2.

Pine Creek, Northern Territory, 1914.—Two stations, *A* and *B*, were occupied. Station *A* is an approximate reoccupation of station of 1912. On ant-bed flat on township-reserve southeast of police station, 176.8 feet (53.89 meters) from south corner post and 242.5 feet (73.91 meters) from east corner post of police-station reserve; marked by cypress peg driven flush with ground and covered with small mound of earth. True bearings: south corner post of police-reserve, 112° 38′.3; east corner post of police-reserve, 165° 14′.3; telegraph-pole seen between two houses near railway, 530 feet (162 meters), 217° 01′.6; rightmost veranda post of railway station, 650 feet (198 meters), 247° 34′.2; left edge of railway tank, 900 feet (274 meters), 267° 40′.3; near gable end of engine shed, 1,000 feet (305 meters), 274° 10′.7; left edge of hotel, 600 feet (183 meters), 286° 09′.7.

As a large quantity of scrap iron lay in vicinity, an auxiliary station, *B*, was established on small flat east of police-station reserve and west of railway station, at south edge of belt of small timber, 275 feet (83.8 meters) north 47° 01′.6 east from main station, about 225 feet (68.5 meters) from east corner of police-reserve, 215 feet (65.6 meters) south-southwest of fence corner; marked by cypress-pine peg set just below ground. True bearings: fence corner, 199° 16′.6; left edge of railway tank, 279° 42′.1; near gable end of engine shed, 286° 01′.2.

Pinjarrega, Western Australia, 1916.—Three stations were occupied, on a flat sand-plain, about 12 miles (19 km.) west of Marchagee siding on Midland Railway, about 6 miles (10 km.) west of Mr. E. W. Paton's farmhouse, about 1 mile (1.6 km.) north of Pinjarrega Lake, surrounded on north and northeast by a patch of timber, on east by level stretch of open country with distant hills, and on south and west by low hills, with two prominent hills about 1 mile (1.6 km.) southeastward. Stations *A*, *B*, and *C* form an equilateral triangle with sides approximately 675 feet (206 meters) long, station *A* being at the north, station *B* at the east, and station *C* at the west.

Station *A* is 20 paces west of a large mallee bush, and about 400 feet (122 meters) south of patch of timber; marked by a 2-inch (5 cm.) rough peg projecting about 4 inches (10 cm.) above ground. True bearings: tree-trunk on horizon, about half mile (0.8 km.), 45° 21′.6; highest point on hill to west, 83° 54′.5; highest point on hill to southeast, 324° 21′.6.

Station *B* is marked by a rough 2-inch (5 cm.) peg projecting about 4 inches (10 cm.) above ground. True bearings: tree on hill, three-fourths mile (1.2 km.), 90° 15′.3; station *A*, 149° 56′.7.

Station *C* is marked by a rough 2-inch (5 cm.) peg projecting about 4 inches (10 cm.) above ground. True bearings: station *A*, 209° 54′.4; tree on horizon about 1.5 miles (2.4 km.), 270° 25′.6.

Piper Head, Northern Territory, 1914.—At an old trepang camp, on beach of large sandy flat, about 500 feet (152 meters) southeast of whitish cliffs of Piper Head, about 70 feet (21 meters) above high-water mark, 50 feet (15.2 meters) west of southwest corner of most westerly shed, and in line with its south side; marked by stake driven several inches below ground.

Playford, Northern Territory, 1914.—See Pine Creek.

Point Charles Lighthouse, Northern Territory, 1914.—Within lighthouse-reserve, about one-fourth mile (0.4 km.) east of lighthouse inclosure, and about 160 feet (49 meters) south of edge of cliff, 94 feet (28.7 meters) south 65° 28′.8 west of survey peg R 44 at northeast corner of reserve, and 202.5 feet (61.72 meters) south-

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Point Charles Lighthouse, Northern Territory, 1914—cont'd. east of northwest corner of plantation fence; marked by ironwood stake driven flush with ground at vertex of two short trenches forming a right angle. True bearings: left edge of chimney of cottage, 96° 01′.9; left gable end of store of lighthouse, 99° 55′.6; top of vane on lighthouse, 101° 36′.3; northeast corner of lighthouse inclosure, 108° 39′.9; northwest corner of plantation fence, 222° 40′.2.

A secondary station was established at a point 300 feet (91 meters) west in direction of left edge of chimney of cottage, to test for local disturbance.

Port Augusta, South Australia, 1914.—On small sand-hill on highest part of park lands, east of transcontinental railway cut, south of track to cricket-ground, and west of cricket-ground; marked by drill-hole in top of concrete block 7 by 8 inches (18 by 20 cm.) set flush with ground. True bearings: gable end of goods-shed, 1,200 feet (366 meters), 24° 02′.4; town-hall spire, one-half mile (0.8 km.), 108° 02′.5; brewery spire, one-third mile (0.5 km.), 111° 46′.9; cross on cathedral, 1,200 feet (366 meters), 162° 04′.8; trigonometric station on Mount Brown, 12 miles (19 km.), 273° 36′.1; east corner of Pastoral Hotel, 1,200 feet (366 meters), 349° 43′.5.

Port Darwin, Northern Territory, 1914.—See Darwin.

Port Essington, Northern Territory, 1914.—See Victoria.

Port Frankland, Western Australia, 1914.—In east corner of Mr. Pierre Bellanger's paddock, on east bank of Frankland River, 98 feet (29.9 meters) from northeast fence, and 86.5 feet (26.37 meters) northwest of road to Denmark. True bearing: near gable of Mr. Bellanger's house, 47° 42′.8.

Port George IV, Western Australia, 1914.—At Port George Mission, 221½ feet (67.51 meters) northeast of northeast corner of fence surrounding mission house; marked by stake projecting 1 foot (30 cm.) above ground and surrounded by cairn of stones. True bearing: left edge of chimney on mission house, about 300 feet (91 meters), 58° 56′.4.

Port Hedland, Western Australia, 1914.—On waste ground east of Esplanade, about 370 feet (113 meters) south of telegraph-line, about 450 feet (137 meters) north of railway track, and 13.0 feet (4.0 meters) east-southeast of prominent tree stump; marked by tent peg driven just below ground. True bearings: near gable end of tide-gage house on jetty, about three-fourths mile (1.2 km.), 55° 11′.0; top lefthand corner of porch in front of Esplanade Hotel, 1,000 feet (305 meters), 87° 26′.7; ornament on steeple of St. Matthew's Church, about one-third mile (0.5 km.), 157° 57′.3; right edge of tank by railway sheds, about 1¾ miles (2.8 km.), 259° 37′.7.

Port MacDonnell, South Australia, 1918.—On beach, opposite Bookie Street and west of main road and jetty, 39.3 feet (11.98 meters) west of east side of Bookie Street extended 129.5 feet (39.47 meters) south from corner of Pascoe's Hotel; marked by survey mark, a concrete circle flush with ground, engraved Geodetic and Magnetic Survey of S. A., with cross arms pointing north-south and east-west, engraved $\phi=38° 3' 25''$, $\lambda=140° 41' 39''$. True bearing: knob on Cape Northumberland Lighthouse, 3 miles (5 km.), 267° 20′.8. A meridian mark is fixed 1 chain (20.1 meters, north of station.

Port Victor, South Australia, 1914.—Exact reoccupation of station of 1911. On hill about 2 miles (3 km.) northwest of town, in southeastern part of quarry-reserve belonging to town, 103.5 feet (31.55 meters) from south fence, and 136.5 feet (41.61 meters) from northeast fence inclosing reserve; marked by jarrah peg 2 by 3 by 20 inches (5 by 7 by 51 cm.) set a short distance below surface. True bearings: highest chimney in old tower, 3 kilometers, 262° 15′.0; gable of red brick store in town, 3 kilometers, 283° 57′.8; flagpole on Granite Island, 3 kilometers, 295° 42′.8. Dip observations were made at a secondary station 98 feet (29.9 meters) north of main station.

Rabbit-Proof Fence 1, Western Australia, 1914.—About 1 mile (1.6 km.) due west of gate in rabbit-proof fence, at mile-post 129 south of Burracoppin, in line with north fence of small garden in front of boundary-rider's hut, and 103 feet (31.4 meters) from northeast corner post of garden fence. True bearings: right edge of rain gage, 47° 15′.4; left edge of hut near ground, 66° 48′.1.

Rabbit-Proof Fence 2, Western Australia, 1914.—Near center of inclosure on east side of rabbit fence, 21 miles (33.8 km.) south of Burracoppin, 528 feet (160.9 meters) from nearest point of fence, 373 feet (113.7 meters) north-northeast of door of boundary-rider's hut, 211 feet (64.3 meters) south of south corner of wooden fence inclosing a water-hole; marked by jarrah peg set just below ground. True bearings: handle on door of boundary-rider's hut, 9° 16′.6; west corner post of inclosure around water-hole, 160° 32′.6.

Rabbit-Proof Fence 3, Western Australia, 1914.—About 20 feet (6.1 meters) south of path leading from rabbit fence to boundary-rider's hut No. 69, and 208.5 feet (63.55 meters) west-northwest from southwest corner of hut; marked by jarrah peg driven flush with ground. True bearing: southwest corner post of hut, 280° 00′.4.

Raspberry Creek Bore, South Australia, 1914.—On south slope of mound, 40 yards (36.6 meters) south of bore-pipe at summit of mound, on south side of Arckaringa Creek. True bearings: west end of horizontal section of bore-pipe, 139° 32′.3; middle of top east bolt at east end of horizontal section of bore-pipe, 160° 38′.0.

Red Hill, New South Wales, 1915, 1916.—Two stations were occupied at Red Hill branch of Sydney Observatory at Pennant Hill. Station *A* is an exact reoccupation of C. I. W. station of 1906 and station *A* of 1913, on limestone pier in magnetic hut.

Station *B* is a close reoccupation of C. I. W. station *B* of 1913, 93 feet (28.3 meters) from *A* whose true bearing is 25° 42′.6.

Robe, South Australia, 1917.—On water-front, south of beach and esplanade, southeast of jetty, in line with street adjoining esplanade, and 80.5 feet (24.54 meters) east of Harbors Board flagstaff; marked by iron peg driven into ground. True bearings: Harbors Board flagstaff, 98° 26′.2; Robe obelisk, at top, three-fourths mile (1.2 km.), 126° 53′.4; highest point on Mount Benson, 12 miles (19 km.), 199° 42′.0; flagpole on Anglican church, one-fourth mile (0.4 km.), 343° 31′.2.

Rockhampton, Queensland, 1914.—Exact reoccupation of station of 1913. In recreation-reserve bounded by North and Campbell streets, 396.5 feet (120.85 meters) from north corner of reserve at Exhibition and Lion Creek roads, and 160.5 feet (48.92 meters) from northeast boundary fence; marked by hardwood peg covered with cairn of bricks and stones. True bearings: center of tower on roof of school, three-fourths mile (1.2 km.), 26° 17′.4; cross on front of frame church, half mile (0.8 km.), 46° 27′.2; front cross on roof of church on brow of hill, three-fourths mile (1.2 km.), 61° 54′.4; left spike on stables, 800 feet (244

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Rockhampton, Queensland, 1914—continued. meters), 86° 55′.1; right spike on stables, 900 feet (274 meters), 94° 05′.1; center of bottom of flag-staff on pavilion, 850 feet (259 meters), 209° 16′.2; spike on tower of Kent Brewery, one-third mile (0.5 km.), 311° 40′.2.

Roper River, Northern Territory, 1914.—See Mission Station (Roper River).

Roseworthy, South Australia, 1915.—In paddock of Mr. Faehse, used as local recreation-ground, about half mile (0.8 km.) east of railway line, just east of main north road, 5.3 feet (1.62 meters) south of center of south end of cricket-pitch, and 203.1 feet (61.90 meters) northeast of Barossa Water Works bench-mark at east side of road. True bearings: west edge of double chimney of Faehse's house 7° 11′.7; center of south chimney-pot of house west of road, 45° 46′.9; Barossa Water Works bench-mark, 61° 52′.4; north edge of chimney of house toward chaff sheds, 94° 21′.2; high bald conical knob in hills, 296° 27′.2; center of cone on Mt. Crawford, 327° 04′.1.

Rosie's Creek, Western Australia, 1914.—About 1 mile (1.6 km.) eastward from point where Moola Bulla–Alice Downs road crosses Great Panton River, and one-fourth mile (0.4 km.) north of road, on east bank of Rosie's Creek, 150 feet (45.7 meters) southwest of southeast corner of horse paddock, and 85.5 feet (26.06 meters) south of south fence.

Rottnest Island, Western Australia, 1914.—Almost exact reoccupation of station of 1912, being 0.7 foot (0.21 meter) east of former station, about 12 miles (19.3 km.) west of Fremantle, near camps constructed for visitors by Tourist Department of government of Western Australia; on highest point of low ridge running parallel to shore, east of jetty on seaward side of old road running along top of ridge; marked by jarrah peg sunk just below ground. True bearings: main lighthouse, 2.7 miles (4.3 km.), 83° 22′.4; trigonometric station on Mt. Herschell, 1.4 miles (2.25 km.), 114° 45′.1; Bathurst Lighthouse, 1.0 mile (1.61 km.), 149° 41′.9; top of rotunda near jetty, 161 feet (49.1 meters), 177° 15′.3; trigonometric station on Point Philip, 0.4 mile (0.6 km.), 278° 46′.1.

Ryan's Bend, Northern Territory, 1914.—On sandy flat at east end of large rocky permanent water-hole in Batten's Creek, about one-fourth mile (0.4 km.) north of road from Borroloola to Katherine, and 18 miles (29 km.) from Borroloola, near blacks' camp, about 70 yards (64 meters) south of big arched rock in water-hole, 74 feet (22.6 meters) south-southeast from tree marked with cross, and 128 feet (39.0 meters) southeast of white gum-tree on bank of creek. True bearings: gum-tree marked with cross, 74 feet (22.6 meters), 165° 50′.6; white gum tree on bank of creek, about 600 feet (183 meters), 236° 32′.4.

Scamander, Tasmania, 1914.—Station *A* is on south side of Scamander River where road from St. Mary's turns sharply to left before reaching approach to bridge across river, 140 feet (42.7 meters) north-northeast of Tasmanian Magnetic Survey station-mark, 61 feet (18.6 meters) north-northeast of old station of Tasmanian Magnetic Survey, and in line between station mark and right edge of bathing-beach shed on north bank of river. True bearing: right edge of bathing-beach shed, 192° 13′.4.

Station *B*: azimuth observations were also made over station-mark of Tasmanian Magnetic Survey, which is a cylinder of Muntz metal imbedded in rock in garden of Ocean Beach or Scamander Hotel. True bearings: right edge of center chimney of Scamander Hotel, one-third mile (0.5 km.), 173° 43′.4; left edge

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Scamander, Tasmania, 1914—continued. of right chimney of Scamander Hotel, 174° 23′.5; right edge of bathing-beach shed, one-third mile (0.5 km.), 192° 13′.4; western extremity of Paddy Island, 15 miles (24 km.), 204° 22′.7; center of saddle between two peaks, 19 miles (31 km.), 205° 40′.9; western extremity of eastermost islet off large island, 5 miles (8 km.), 210° 22′.0.

Sir Edward Pellew Islands, Northern Territory, 1914.—At west end of sandy point, about midway between most westerly of Craggy Islands and North Island of Sir Edward Pellew Islands, about west of middle point of North Island, and about 150 feet (46 meters) from edge of reef, in saddle between sandy bluff and sandy scrub-covered ridge. True bearing: east end of most westerly of Craggy Islands, 70° 55′.6.

Six-Mile Hotel, Western Australia, 1914.—On east side of creek, 225 paces south from Six-Mile Hotel, respectively 51 paces and 47 paces from telegraph-poles west-northwest and southeast. True bearings: left edge of left veranda-post of hotel, 225 paces, 189° 08′.9; right edge of right veranda post of hotel, 228 paces, 197° 27′.5.

Southport, Tasmania, 1914.—Three stations, designated *A*, *B*, and *C*, were established. *A* is on small flat on ridge behind Southport Hotel, 34 feet (10.4 meters) northeast of nearest point of fence. True bearings: center of outermost mooring-post of pier, half mile (0.8 km.), 272° 05′.4; ventilator on building on nearest point across bay containing pier, 1 mile (1.6 km.), 288° 14′.1; Bruni Head Lighthouse, 14 miles (22.5 km.), 294° 37′.6.

Station *B* is at a point above the beach about one-fourth mile (0.4 km.) up the harbor from the hotel and past the church.

Station *C* is about three-fourths mile (1.2 km.) beyond *B* along the beach, on point where greenstone outcrops.

Spinifex Camp, Western Australia, 1914.—On Canning stock route, at camp about midway between wells 33 and 34, in fairly thick patch of poplars, wattles, etc.

Stanley's Well, South Australia, 1914.—On a low hill west of Stanley's Well, and north of Wintinna Creek, 114 yards (104.2 meters) from well, one-fourth mile (0.4 km.) northeast of Christmas Well; marked by small pile of stones and a buried pickle bottle containing inscription: Stanley's Well magnetic station, Oct. 23d, 1914. True bearings: center of Christmas Well, 19° 41′.1; center of Stanley's Well, 268° 26′.7; edge of northeast wall of galvanized-iron house 310° 03′.3.

Strahan, Tasmania, 1914.—About 1.5 miles (2.4 km.) east of Bay View Hotel, in valley north of the rifle range, approximately in line with Featherstone Street, about 70 feet (21 meters) south of small stream that flows into Long Bay, and about 431 feet (131 meters) northeast of small cairn at astronomic station of Tasmanian Magnetic Survey; marked by hardwood post set flush with ground and covered by large stone. True bearings: left spike on roof of two-chimneyed house on top of cliffs, 2 miles (3.2 km.), 98° 50′.2; right edge of right chimney of Bay View Hotel, 105° 04′.8; center of ornament over J. Wood's store, 106° 35′.0; bottom of flagstaff over offices of Union Steamship Co., 107° 21′.6; center of left veranda post of Macquarie Harbor Hotel, 108° 15′.1; left gable end of house on side of hill, three-fourths mile (1.2 km.), 112° 47′.0; lone tree on opposite bank of small stream, 90 feet (27 meters), 195° 30′; near gable end of rifle-butts building, two-thirds mile (1.1 km.), 299° 13′.0.

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Sturt Creek, Western Australia, 1914.—About half mile (0.8 km.) west of Sturt Creek and 3 miles (4.8 km.) from old Denison Downs homestead.

Sunday Island, Western Australia, 1914.—About 700 feet (213 meters) west-southwest of mission dwelling-house; marked by stake projecting 18 inches (46 cm.) above ground and surrounded by cairn of stones. True bearing: left gable end of dwelling, 247° 00′.6.

Sydney Observatory, New South Wales, 1914.—See Red Hill B.

Tallering, Western Australia, 1916.—Three stations were occupied, on north side of salt-flat, the western extension of which is known as "the race-course," about 3.5 miles (5.66 km.) north of Mr. Cornish's house at Karla Spring, about 2.5 miles (4.0 km.) along road following fence leading northward from road from Mr. Cornish's house. Station *A* is in line with fence along road and about 1,084 feet (330.4 meters) north of a fence running east and west along south side of salt-flat; marked by a rough peg 2 inches (5 cm.) in diameter, projecting about 3 inches (8 cm.) above ground. True bearings: nearest post of fence leading southward, 1° 03′.1; center-rod of a windmill, 41° 11′.7.

Station *B* is about 805 feet (245.4 meters) southwest of station *A*; marked by a rough peg 2 inches (5 cm.) in diameter, projecting about 3 inches (8 cm.) above ground. True bearings: center-rod of windmill, 50° 19′.8; station *A*, 211° 02′.6.

Station *C* is about 805 feet (245.4 meters) southeast of station *A*, and about 805 feet (245.4 meters) east of station *B*; marked by a rough peg 2 inches (5 cm.) in diameter, projecting about 3 inches (8 cm.) above ground. True bearings: center-rod of a windmill, 68° 46′.2; station *B*, 89° 38′.7; station *A*, 151° 00′.7; east end of roof of shearing shed at Karla Spring, 355° 50′.3.

Tallering (Sand-plain), Western Australia, 1916.—Three stations were occupied, about 5 miles (8 km.) northwest of Karla Spring, on a bush-covered sand-plain on south side of road leading to Warren's Flat. Station *A* is about 200 feet (61 meters) south of road; marked by a rough peg 2 inches (5 cm.) in diameter, projecting 3 inches (8 cm.) above ground.

Station *B* is about 640 feet (195 meters) south 33° 30′.6 east of station *A*; marked by a rough peg 2 inches (5 cm.) in diameter, projecting 3 inches (8 cm.) above ground.

Station *C* is about 640 feet (195 meters) south 26° 26′.8 west of station *A*, and about same distance west of station *B*; marked by a rough peg 2 inches (5 cm.) in diameter, projecting 3 inches (8 cm.) above ground.

Tarcoola, South Australia, 1914.—On rising ground north of township and about half mile (0.8 km.) north-northeast of post-office; marked by jarrah peg painted white and driven flush with ground. True bearings: gable of post-office, half mile (0.8 km.), 10° 53′.6; gable of police station, half mile (0.8 km.), 16° 25′.6; near corner of hut on hill, 1 mile (1.6 km.), 48° 45′.0; center shaft of windmill, three-fourths mile (1.2 km.), 50° 36′.3; center of poppet-head, three-fourths mile (1.2 km.), 338° 17′.3; gable of tin hut, one-third mile (0.5 km.), 356° 21′.2.

Thursday Island, Queensland, 1915.—Exact reoccupation of station *A* of 1912, on military-reserve north of fort and south of quarantine station, midway on high cliff north of valley between fort and first hill along beach, 150 yards (137 meters) south of garrison jetty; marked by red-gum peg 15 inches (38 cm.) long projecting 6 inches (15 cm.) out of ground and surrounded with rocks. True bearings: Goode Island Lighthouse, 4 miles (6.4 km.), 105° 06′.9; right edge of cable test house on Hammond Island, 135° 30′.2; bottom of high flagstaff on fort, 295° 03′.0.

Timber Creek, Northern Territory, 1914.—On hard sandy flat about 200 yards (183 meters) northwest of police station, and 83 feet (25.3 meters) southwest of west corner of goat paddock, and about in line with northwest side of paddock; marked by small hardwood peg driven flush with ground. True bearings: west end of goat paddock, 214° 57′.0; left edge of kitchen at police station, 650 feet (198 meters), 298° 15′.0; leftmost veranda post of police station, 299° 43′.4; rightmost edge of black trooper's cottage, 350 yards (320 meters), 309° 16′.8.

Todmorden, South Australia, 1914.—East 110 yards (100.6 meters) from the homestead, which is on a sandy rise near flood plain of Alberga River; marked by post bearing a brass plate with inscription: C. I. Magnetic Station. Todmorden. Long. 134° 45′ 16″ E; Lat. 27° 08′ 28″ S. Magnetic variation 4° 0′ E. Sept. 7th, 1914. True bearing: windmill southwest of homestead, 73° 39′.6.

Turkey Creek, Western Australia, 1914.—On east bank of Turkey Creek, about 390 feet (119 meters) north of main post-office building. True bearings: right end top of roof ridge of lineman's house, 600 feet (183 meters), 4° 58′.4; near gable end of stable, 800 feet (244 meters), 12° 31′.2; right edge of police station, 900 feet (274 meters), 97° 56′.6; left iron pole at bathroom, 300 feet (91 meters), 350° 54′.1; northwest corner of main post-office building, 354° 27′.6.

Twenty-Mile Landing, Northern Territory, 1914.—On small open flat on right bank of King River, about 20 miles (32 km.) above mouth of river, about 500 feet (152 meters) north-northeast of landing at old buffalo-shooter's lodge, about midway between tall trees of forest and a grove of mangroves at edge of river, 76 feet (23.2 meters) southwest of tall blazed paper-bark tree, and 90 feet (27.4 meters) northwest of gum tree marked C. I. W.; marked by iron-wood peg sunk level with ground and covered with small mound of earth. True bearings: blazed paper-bark tree, 76 feet (23.2 meters), 246° 07′.3; top of "I" in marked white gum-tree, 90 feet (27.4 meters), 313° 06′.3.

Victor Harbor, South Australia, 1914.—See Port Victor.

Victoria, Northern Territory, 1914.—On beach at old military settlement of Victoria (Port Essington) about midway between reddish cliff at north end of bay and mangrove-covered point at south end, and 41 feet (12.5 meters) west of high-water mark; marked by cement block 8 inches by 2 feet (20 by 61 cm.) sunk flush with ground and marked C I W . 1914 and covered with small heap of stones. True bearings: end of reddish cliff at north end of bay, one-fourth mile (0.4 km.), 203° 49′.0; end of square rock at end of point across bay, 4 miles (6.4 km.), 243° 10′.0; bottom of trunk of end mangrove at south point of bay, one-fourth mile (0.4 km.), 319° 36′.6.

Victoria River, Northern Territory, 1914.—On south bank of Victoria River, about 1 mile (1.6 km.) below Mosquito Flat, and in that part of river known as Gunn's Log, 5 feet (1.5 meters) above flood-mark of river, and about 30 feet (9.1 meters) from mangroves fringing bank. True bearings: top of cone-shaped mountain, 12 miles (19 km.), 50° 51′.8. Approximate bearings from boat in river, using ship's compass: magnetic station, 17°; conical hill, 46°; circular head, 10 miles (16 km.), 263°; south end of Bradshaw's tomb, 267°.

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Victoria River, Northern Territory, 1914.—See also Depot.

Wadawalla, Western Australia, 1914.—On Canning stock-route, 136 feet (41.5 meters) west of dump of well No. 40, known locally as Wadawalla. True bearing: fork at well, 276° 30′.2.

Wanda, Western Australia, 1914.—On Canning stock route, about 40 paces north of No. 36 well, locally known as Wanda.

Wantapella, South Australia, 1914.—About one-fourth mile (0.4 km.) north of swamp, and 300 yards (274 meters) north of homestead; marked by buried log, also pickle bottle containing inscription: Wantapella magnetic station, Sept./Oct. 1914. True bearings: center of well at homestead, 22° 12′.6; high tree near Mt. Chandler trigonometric station, 9 miles (14.5 km.), 99° 31′.6; Mt. Chandler trigonometric station, 99° 33′.1; center of hollow of large gum tree, 100 yards (91 meters), 224° 37′.2.

Wardabunna, Western Australia, 1914.—On Canning stock-route, on flat near foot of sandhill, about 200 yards (183 meters) north of Wardabunna rock-hole, which is No. 38 water of stock-route.

Warren's Flat, Western Australia, 1916.—Three stations were occupied, about 1 mile (1.6 km.) east of a well and windmill which are about 7 miles (11 km.) northwest of Karla Spring. Station *A* is about 300 feet (91 meters) north of a road running eastward from well; marked by a rough peg 3 inches (8 cm.) in diameter, projecting about 5 inches (13 cm.) above ground.

Station *B* is about 690 feet (210 meters) south 32° 48′.8 east of station *A*, on south side of road; marked by a rough peg 3 inches (8 cm.) in diameter, projecting about 5 inches (13 cm.) above ground.

Station *C* is about 690 feet (210 meters) south 27° 12′.2 west of station *A*, and about same distance west of station *B*; marked by a rough peg 3 inches (8 cm.) in diameter, projecting about 5 inches (13 cm.) above ground.

Water No. 2A, Western Australia, 1914.—Near No. 2A water on Canning stock route, 100 paces west-southwest of wall around excavation for water.

Water No. 17, Western Australia, 1914.—At camp near some bloodwood trees, on flat in valley about one-third mile (0.5 km.) below Killagurra Springs.

Water No. 38, Western Australia, 1914.—See Wardabunna.

Water No. 42, Western Australia, 1914.—See Guli.

Watheroo, Western Australia, 1916, 1917.—Station *A* occupied in 1916 is on railway-reserve, between railway dam and western boundary fence of reserve, 71 feet (21.6 meters) east of nearest point of boundary fence which is 213 feet (64.9 meters) south of small vegetable garden in northwest corner of reserve, about 93 feet (28 meters) west of near edge of a dry creek bed lying nearly north and south, and 9 feet (2.7 meters) south of a small mallee tree; marked by a wooden peg left about 3 inches (8 cm.) above surface of ground. True bearings: east edge of chimney on house seen through trees, 167° 27′.0; support of coal chute at railway station, about 900 feet (274 meters), 313° 45′.8.

Three stations, designated *B*, *C*, and *D*, were occupied in 1917, at three roughly equidistant points on a flat stretch of sand-plain about 2 miles (3 km.) west of McGowan's farm, and about 11 miles (18 km.) west of Midland Railway line. Station *B* is about 800 feet (244 meters) northwest of a prominent lone Christmas tree; marked by a stake left about 3 inches (8 cm.) above ground. True bearings: McGowan's farmhouse, 256° 37′.5; tree on hill, about 6 miles (10 km.), 275° 52′.8; lone Christmas tree, 322° 31′.4.

Station *C* is about 500 feet (152 meters) southeast of station *B*, and about 300 feet (91 meters) northwest of a prominent lone Christmas tree; marked by a stake left about 3 inches (8 cm.) above ground. True bearings: station *B*, 146° 41′.5; tree on hill, about 6 miles (10 km.), 275° 18′.0.

Station *D* is about 500 feet (152 meters) southwest of station *B* and about 500 feet (152 meters) west of station *C*, and 15 feet (4.6 meters) north of south boundary of observatory block; marked by a stake left about 3 inches (8 cm.) above ground. True bearings: station *B*, 204° 30′.2; tree on hill, about 6 miles (10 km.), 275° 08′.5; lone Christmas tree, 282° 37′.2.

Watheroo Observatory, 1917–1919.—Before completion of observatory buildings, four stations were occupied on site of Watheroo Magnetic Observatory. Station *F* and *G* are located near southwest corner of paddock surrounding well in northwest corner of site; *F* is 304 feet (92.7 meters) southwest of well and *G* is 67 feet (20.4 meters) west-northwest of *F*. Station *H* was as nearly as possible at center of site of variation observatory. Station *I* was as nearly as possible at center of site of absolute observatory.

The stations regularly used for control of variometers are piers N_m and N_w in absolute observatory, the former being the central of three piers at north end of building and the latter the pier in northwest corner of building. The mark used for declination work at N_m is center of two black lines on board 947.6 feet (288.83 meters) distant in true bearing 265° 06′.6 west of south. Pier S_m in absolute observatory is the central of three piers at south end of building. The mark used is same as for N_m and distant 951.6 feet (290.05 meters) in true bearing 263° 35′.9.

Weld Spring, Western Australia, 1914.—On Canning stock-route, 310 feet (94.5 meters) north of dump at No. 9 well at Weld Spring. True bearing: right support of well windlass, 0° 59′.0.

Well No. 4, Western Australia, 1914.—On Canning stock-route, southwest of railing around No. 4 well. True bearing: near corner of railing around well, 101 feet (30.8 meters), 240° 19′.

Well No. 5, Western Australia, 1914.—On Canning stock-route, 294 feet (89.6 meters) west of dump at No. 5 well. True bearing: groove in pulley over well, 310 feet (94.5 meters), 273° 00′.8.

Well No. 7, Western Australia, 1914.—On Canning stock-route between Wiluna and Hall's Creek, 346 feet (105.5 meters) south-southwest of well dump. True bearing: right edge of pulley over well, 360 feet (110 meters), 195° 00′.2.

Well No. 9, Western Australia, 1914.—See Weld Spring.

Well No. 11, Western Australia, 1914.—See Goodwin Soak.

Well No. 13, Western Australia, 1914.—About 40 yards (37 meters) north of No. 13 well of Canning stock-route.

Well No. 15, Western Australia, 1914.—On Canning stock-route, 125 feet (38.1 meters) east-northeast of nearest corner of dump at well No. 15. True bearing: center of well, 77° 16′.

Well No. 19, Western Australia, 1914.—On Canning stock-route, one-fourth mile (0.4 km.) north-northeast of No. 19 well, and about 30 paces east of tree with "J. Bruce Lumley Exploring Expedition 1911" carved on it. True bearing: bottom of fork at well, 29° 12′.7.

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Well No. 21, Western Australia, 1914.—On Canning stock-route, 77 feet (23.5 meters) west of nearest upright of windlass of No. 21 well. True bearing: nearest upright of windlass, 272° 14′.2.

Well No. 24, Western Australia, 1914.—See Karara Soaks.

Well No. 27, Western Australia, 1914.—On Canning stock-route, 132 feet (40.2 meters) northeast of near corner of well dump. True bearing: near support of well windlass, 43° 37′.

Well No. 29, Western Australia, 1914.—On Canning stock-route, about 235 yards (215 meters) north-northwest from No. 29 well and 43 feet (13.1 meters) north-northwest from center of lone bloodwood tree. True bearings: center of lone bloodwood, 329°; left edge of whip pulley, 331° 32′.2.

Well No. 31, Western Australia, 1914.—On Canning stock-route, 210 feet (64 meters) southwest from near corner of railing around dump of No. 31 well. True bearing: center of near support of well windlass, 228° 40′.

Well No. 36, Western Australia, 1914.—See Wanda.

Well No. 40, Western Australia, 9114.—See Wadawalla.

Well No. 43, Western Australia, 1914.—See Billowaggi.

Well No. 46, Western Australia, 1914.—See Kuduarra.

Well No. 48, Western Australia, 1914.—On Canning stock-route, 104 feet (31.7 meters) from near corner of dump of well 48. True bearing: center of well, 155°.

Well No. 50, Western Australia, 1914.—On Canning stock-route, 182 feet (55.5 meters) from nearest corner of railing at dump of No. 50 well. True bearing: center well, 46° 40′.

Wessel Islands, Northern Territory, 1914.—See Cape Wessel.

White Mark, Tasmania, 1914.—On Flinders Island, in southwest corner of paddock belonging to hotel keeper, Mr. Cronley, on south side of Emmita road, 87.9 feet (26.79 meters) and 111 feet (33.8 meters) respectively from southwest and northwest corners of paddock; marked by hardwood stake set 1 inch (3 cm.) below ground. True bearings: near gable end of iron building, 550 feet (168 meters), 29° 28′.9; center of ornament over front gable of hotel, 380 feet (116 meters), 41° 45′.5; southwest corner of paddock, 73° 41′.1; center of spike on tower of council offices, 1,000 feet (305 meters), 78° 57′.6; front spike on store, 250 feet (76 meters), 95° 03′.0; northwest corner of paddock, 144° 49′.8; center of spike on roof of White Mark Hall, 200 feet (61 meters), 204° 31′.8; left edge of left chimney of doctor's house, 230° 35′.3; middle corner of paddock, 200 feet (61 meters), 252° 34′.3; southeast corner of Cronley's paddock, 200 feet (61 meters), 289° 48′.4; top of cone-shaped mountain, 4 miles (6 km.), 314° 22′.5.

A secondary station was established to test for local magnetic disturbance at a point 150 paces away, in line with magnetic station and spike on tower.

Wild Dog Spring, Western Australia, 1914.—About one-fourth mile (0.4 km.) east-northeast of Wild Dog Spring, and 300 yards (274 meters) west of Wyndham Road.

Wilmington, South Australia, 1916.—On reserve on southeast side of Wilmington township, 593.3 feet (180.84 meters) southwest of corner post on Melrose main road and terrace on township side of reserve, and 357.3 feet (108.91 meters) southeast of end of Melrose Terrace and in line with fencing on east side of terrace; marked by a survey reference mark of cement,

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AUSTRALIA—*continued.*

Wilmington, South Australia, 1916—continued.
flush with ground, and inscribed Geodetic and Magnetic Survey of S. A. on outer circle and $\lambda = 138° 5'.2$; $\phi = 32° 39'.3$ on cross arms. True bearings: east side of top of chimney-stack of old mill, 140° 45′.4; northwest edge of galvanized-iron building, 183° 01′.7; west gable of public school, 187° 27′.5; south edge of south chimney of police residence, 195° 09′.3; north side of cross of Roman Catholic church, 201° 47′.6; south side of cross of Roman Catholic church, 201° 50′.4.

Wiluna, Western Australia, 1914.—About 1 mile (1.6 km.) northeast of township, 300 feet (91 meters) east of road leading to 2-mile well, and 800 feet (244 meters) northwest of Caledonian mine. True bearing: center of bottom of Caledonian mine chimney, 314° 41′.0.

Wirraminna, South Australia, 1914.—About 500 feet (152 meters) north of telegraph-line between Port Augusta and Tarcoola, about 600 feet (183 meters) northeast of One-Mile Well, and 45 feet (13.7 meters) south of mail-track leading to well; marked by drill-hole in top of rough sandstone post 5 by 5 inches (13 by 13 cm.) projecting 5 inches (13 cm.) out of ground.

Wolf Creek, Western Australia, 1914.—Near junction of Wolf and Sturt creeks, about 250 yards (229 meters) northeast of trigonometric post in cairn marked C 21. True bearing: top of trigonometric post, 57° 46′.4.

Wongan Hill, Western Australia, 1916.—Three stations were occupied, arranged roughly as the vertices of an equilateral triangle, with sides about 600 feet (183 meters). Station *A* is north of road to railway station, in open space east of schoolhouse and 100 feet (30 meters) south of wire fence around dam, in line with north school fence, 216 feet (65.8 meters) east of near corner; marked by peg. True bearings: right edge of railway water-tank, 76° 20′.6; pointed ornament on gable of station master's house, 102° 20′.2. Station *A secondary* is 123 feet (37.5 meters) east of station *A* in line from station master's house.

Station *B* is on road leading to gravel pit on hillside in extension through station *A* of line from gable of station-master's house; marked by peg. True bearings: right edge of railway water-tank, 84° 43′.0; ornament on gable of station-master's house, and station *A*, 102° 20′.1.

Station *C* is about 10 feet (3 meters) north of road leading northeastward; marked by peg. True bearings: station *A*, 42° 20′.5; right edge of railway water-tank, 65° 54′.5; ornament on gable of station-master's house, 85° 07′.6; station *B*, 339° 20′.6.

Woondenooka, Western Australia, 1916.—About 10 miles (16 km.) north of Mullewa, 6 miles (10 km.) west of Woondenooka Spring, about three-fourths mile (1.2 km.) west of road running north from Mullewa, in a small clearing surrounded by timber, reached by following bed of a dry creek running westward from road. Three stations, *A*, *B*, and *C* were occupied and all were marked by rough wooden pegs 3 inches (8 cm.) in diameter, projecting 3 inches (8 cm.) above ground. Station *A* is north of creek bed near path. Station *B* is about 580 feet (177 meters) south 33° 38′.1 east of station *A* near south bank of dry creek bed. Station *C* is about 580 feet (177 meters) south 26° 24′.5 west of station *A*, and about same distance west of station *B*.

Wynbring Rock-Hole, South Australia, 1914.—On low level piece of ground, bare of salt-bush, west-northwest of main rock-hole, about 400 feet (122 meters) west-southwest of highest point of rock.

AUSTRALASIA.

AUSTRALIA—*concluded*.

Yallalie Well, Western Australia, 1917.—Near southeast corner of paddock, about 650 feet (198 meters) west of gate near humpy, 292 feet (89 meters) south of center of well and in line with watering-trough on its south side, and 226 feet (68.9 meters) south of near end of trough; marked by a round stake left 4 inches (10 cm.) above ground. True bearings: tree on horizon, about 3 miles (5 km.), 113° 57′.8; approximate center of well, 172° 59′.7; south gate-post near humpy, 267° 41′.9; southeast corner post of paddock, about 900 feet (274 meters), 310° 54′.4.

Yangoonabie, South Australia, 1914.—On flat clayey ground about 400 feet (122 meters) north of underground tanks, about 310 feet (94 meters) north of telegraph-line, and 20 feet (6.1 meters) west of camel-pad. True bearings: east corner post of tank-yard, 400 feet (121.9 meters), 342° 58′.6; gable end of smaller tank, 350 feet (106.7 meters), 350° 49′.7; west corner post of tank-yard, 350 feet (106.7 meters), 355° 05′.8.

NEW ZEALAND.

Cass, South Island, 1915.—About 200 yards northeast of cottage of Canterbury College Biological Station, 25 feet (7.62 meters) south of edge of ravine, and about 75 feet (22.86 meters) southeast of end of wooden trestle carrying water supply pipe over ravine; marked by iron pipe 3 feet (91 cm.) long driven in ground. True bearings: small knob in deep V on ridge west of Mount Cockayne, 49° 13′.4; south edge of railroad water-tank, 71° 40′.7; triangulation station on Sugarloaf Mountain, 277° 02′.4.

Christchurch, South Island, 1915, 1916, 1920.—Observations were made on East Pier and West Pier of absolute house of Christchurch Observatory, and at stations designated Jarrah Peg and Brass Pipe. Jarrah Peg is station "peg A" of 1907–8, and is 12.14 meters north of northeast corner of absolute house and 14.10 meters northeast of northwest corner. True bearing: iron pipe, RM_1, 196° 03′.8; iron pipe 2, 200° 13′.3. Brass Pipe is identical with station of that name occupied in 1907–8, 21.70 meters northeast of Jarrah Peg. True bearing: iron pipe 2, 195° 14′.2.

Clinton, 1916.—Approximate reoccupation of New Zealand Magnetic Survey station, near south corner of a triangular meadow belonging to police department, about one-fourth mile (0.4 km.) southwest of railroad station, north of stock-yards and west of Prince of Wales Hotel stables, 171 feet (52.1 meters) south of survey peg marked 23–24 on north fence of meadow, 45 feet (13.7 meters) from nearest point of wire fence to west, 99 feet (30 meters) north of south corner of meadow, and 74 feet (22.6 meters) from nearest point of wooden fence to southeast; marked by a wooden peg. True bearing: flagpole in town, seen above Prince of Wales Hotel stables, 1,000 feet (0.3 km.), 280° 35′.4.

Eketahuna, 1916.—In southwest corner of domain, 135 feet (41.1 meters) north of eastern gate-post at entrance from road, 96 feet (29.3 meters) east of western boundary fence of domain, measured through hedge, 135 feet (41.1 meters) north of southern boundary fence, and 54 feet (16.5 meters) south of rail around race-track; marked by a wooden peg. True bearings: conspicuous bare tree on hill, 2 miles (3 km.), 14° 49′.2; ornament on front gable end of house, seen through hedge, 69° 56′.9; near gable end of pavilion, 300 feet (91 meters), 133° 56′.4; top of left gate-post at entrance to domain, 357° 56′.8.

Kingston, 1916.—In open space about 450 feet (137 meters) southwest of railway station and about 600 feet (183 meters) south-southeast of hotel, 72 feet (21.9 meters) east of corner of wire fence near cow sheds, and 106 feet (32.3 meters) north of corner of wire fence which is about 110 feet (34 meters) southeast of first corner; marked by a wooden peg. True bearings: right edge of chimney-stack on house, 130 feet (40 meters), 157° 04′.5; right edge of front chimney-stack on station-master's house, 500 feet (152 meters), 208° 59′.5; near gable end of house among trees, half mile (0.8 km.), 320° 05′.3.

Manapouri, 1916.—Near apex of a roughly triangular space formed by two branches of coach road in front of tourist accommodation house, about 56 feet (17 meters) southwest of junction of inside edges of branch roads, about 16 feet (5 meters) south of nearest point of north branch, about 15.5 feet (4.7 meters) northwest of nearest point of branch on southeast, 29.2 feet (8.90 meters) west of road-survey peg, and 81 feet (24.7 meters) northeast of nearest telegraph-post within triangle; marked by a wooden peg. True bearings: spike on small gable end of accommodation house, 250 feet (76 meters), 59° 00′.0.

Mount Victoria, Wellington, 1916.—On eastern side of ridge extending from Mount Victoria to Mount Albert, overlooking Lyall Bay, about half mile (0.8 km.) from Mount Albert, in a paddock east of road leading from Constable Street along top of ridge north to Mount Victoria just north of first wicket gate, 59 feet (18.0 meters) east down hill from fence along east side of road, and 78 feet (23.8 meters) north of wire fence running east from wicket gate; marked by a wooden peg. True bearings: right edge at widest part of chimney on near house, 250 feet (76 meters), 116° 54′.3; flagstaff on Mount Victoria, 2 miles (3 km.), 194° 11′.9; center of cross on church in valley, three-fourths mile (1.2 km.), 230° 47′.2; flagstaff at signal-station across bay, 2 miles (3 km.), 300° 58′.3.

New Brighton Beach, South Island, 1915.—Exact reoccupation of C. I. W. station of 1908, on beach about 1,240 paces south of recreation-pier, and 10 paces east of edge of grass; marked by jarrah post projecting 20 inches (51 cm.) above ground. True bearings: triangulation station on Mount Pleasant, 4° 22′.3; triangulation station on Sugarloaf Mountain, 35° 27′.3; last seaward pile on recreation-pier, 173° 43′.2; Godley Head Lighthouse at entrance to Port Lyttleton, 323° 15′.2.

Petone, 1916.—Approximate reoccupation of New Zealand Magnetic Survey station, in northern section of recreation-reserve, 69 feet (21 meters) northeast of wooden fence dividing two sections of reserve, 76 feet (23.2 meters) north of eastern end of wooden fence, and 60 feet (18.3 meters) northwest of wire fence inclosing flower-beds; marked by a wooden peg. True bearings: ornament on front gable end of school, 550 feet (168 meters), 23° 02′.7; cross on front gable of church behind pavilion, 1,000 feet (0.3 km.), 84° 08′.2; ornament on top of band-stand, 360 feet (110 meters), 94° 51′.5; ornament on near pillar of gas-works, 500 feet (152 meters), 168° 35′.8.

Queenstown, 1916.—About 180 feet (55 meters) east-southeast of New Zealand Magnetic Survey station of 1900, southeast of town along beach, about one-fourth mile (0.4 km.) west of town abattoirs, about 30 feet (9 meters) north of path along shore of lake, about 20 feet (6 meters) east of a deep gully running down from hill, 22.5 feet (6.86 meters) south of near post of single-strand wire fence, 96 feet (29.3 meters) west

AUSTRALASIA.

NEW ZEALAND—*concluded.*

Queenstown, 1916—continued. of corner post of main fence around cattle paddock, and 19 feet (5.8 meters) west of road-survey peg by large rock; marked by a wooden peg 1.5 by 1.5 inches (4 by 4 cm.), left level with surface. True bearings: right side of white cottage on farther side of lake, 2 miles (3 km.), 49° 33′.3; right edge of top of brick chimney-stack on near iron shed, 250 feet (76 meters), 94° 07′.2; near gable end of large iron hut on near hill, one-fourth mile (0.4 km.), 269° 17′.3; chimney stack on large hut across water, three-fourths mile (1.2 km.), 309° 06′.3.

Rotorua, 1916.—Reoccupation of New Zealand Magnetic Survey station, near northeast corner of sports-ground between military hospital and triangulation station on Pukeroa Hill, 91 feet (27.7 meters) southeast of near goal post, 81 feet (24.7 meters) south of north boundary of football-field, 109 feet (33.2 meters) southwest of its northeast corner post, and 66 feet (20.1 meters) west of its east boundary; marked by a wooden peg. True bearings: left edge of flagpole on hospital, 119° 11′.3; right edge of flagpole near triangulation station, 317° 00′.8; right edge of south-east corner post of football-field, 352° 38′.4.

Springfield, 1916.—Reoccupation of New Zealand Magnetic Survey station, in southwest corner of Springfield public domain, just north of tennis-courts, about 350 feet (107 meters) northeast of entrance gate, 77 feet (23.5 meters) north-northeast of nearest point of a curved wire fence round northeast end of tennis inclosure, 55 feet (16.8 meters) northwest of white post marking race-track, 82 feet (25.0 meters) southeast of a similar post, and about 15 feet (5 meters) inside track; marked by a peg 1.5 by 1.5 inches (4 by 4 cm.) left level with surface. True bearings: top of left gate-post at entrance to domain, 66° 24′.4; white post near northeast corner of ground, one-fourth mile (0.4 km.), 217° 34′.8.

Te Anau, 1916.—North of Te Anau Hotel facing Lake Te Anau, in north corner of a slight depression in ground, 83 feet (25.3 meters) south of a survey peg on west side of proposed road running northwest, 146 feet (44.5 meters) southwest of corner post of wire fence, opposite survey peg, and 331 feet (100.9 meters) north of west corner of thicket hedge around hotel garden; marked by a wooden peg. True bearings: left edge of flagpole in front of hotel, seen above thicket hedge, 8° 22′.6; south gable end of coal storehouse by jetty, 53° 30′.3; left edge of survey peg on side of proposed road, 159° 11′.9.

Te Awamutu, 1916.—About one-tenth mile (161 meters) north of New Zealand Magnetic Survey station, in a reserve owned by local board, west of sale-yards, about 15 feet (5 meters) west of west edge of gully dividing reserve roughly in half, 108 feet (32.9 meters) northeast of east gate-post of gate leading into reserve, 88.5 feet (27.0 meters) southeast of wire fence at south corner of small shed, and 88 feet (26.8 meters) north of intersection of road fence and west edge of gully; marked by a wooden peg. True bearings: flagpole on Teasdale's buildings, one-fourth mile (0.4 km.), 0° 30′.1; top of tower of church, one-fourth mile (0.4 km.), 65° 43′.1; spike on front gable end of house, 900 feet (274 meters), 219° 29′.1; near gable end of near stables, 350 feet (107 meters), 307° 11′.5.

EUROPE.

GREAT BRITAIN.

Eskdalemuir Observatory, Scotland, 1915.—Observations were made in east and west magnetic huts of observatory. Each hut contains three piers lying in a magnetic east to west line, numbered 1 to 6 from west to east. Piers 2 and 5 were used for declination and intensity, and piers 3 and 6 for inclination.

Greenwich Observatory, England, 1915, 1919.—Observations were made in 1915 at three stations, *Declinometer Station* and *Intensity Pier* in absolute house, and station designated *Tent 1915*, 74 feet (22.6 meters) southeast of southeast corner of absolute house and 29 feet (8.8 meters) north of wall of inclosure.

Declination and inclination observations were made in 1919 at station designated *Tent 1919*, which is a close reoccupation of 1915 station, in inclosure around absolute magnetic observatory 20 paces south-southeast of southeast corner of observatory. As in 1915, horizontal-intensity observations were made on center of *Intensity Pier* in absolute house.

Kew Observatory, England, 1915, 1919.—In 1915 observations were made on center and west piers of old absolute house and on center and west piers of new absolute house, designated O_m, O_w, N_m, and N_w, respectively.

In 1919 observations were made on east, west, and center piers, designated N_e, N_w, and N_m, respectively, of new absolute observatory. True bearing from N_m: obelisk in park, 182° 06′.3.

Stonyhurst College Observatory, England, 1915.—Two stations designated *A* and *B* were used. Station *A* is pier in magnetic hut.

Station *B* is on observatory lawn, 39 feet (11.9 meters) northeast of northeast corner of north room of observatory, and 87.4 feet (26.64 meters) northwest of west corner of an observing pier on east corner of lawn. True bearings: church steeple, 7 miles (11 km.), 6° 18′.1; northeast corner of north room of observatory, 48° 01′; left edge of infirmary, 125° 57′.7; west corner of pier at east corner of lawn, 319° 34′.

NORWAY.

Haaien Island, 1914.—On extreme eastern end of island, at elevation of about 60 feet (18 meters); marked by cross cut in top of large flat rock. True bearing: Melko Lighthouse, 231° 05′.7.

Hammerfest, 1914.—Two stations, designated *A* and *B*, were established on a gentle slope about two-thirds of distance from shore to foot of mountain that rises abruptly to north of stations. *A* is 310.4 meters north-northeast from granite pillar known as "meridianstötten" marking terminus of a meridian arc, about 110 meters east-northeast of nearest point of seashore, about 12.6 meters east of nearest point of bank of small stream, and 16.60 meters west-southwest of nearest telephone-pole. True bearings: meridianstötten, 10° 29′.1; beacon on small island, 29° 45′.0; Grundvaag Lighthouse, 63° 35′.7; beacon on Haaien Island, 77° 23′.9; flagstaff on hotel, 323° 26′.8; Lutheran church spire, 333° 54′.8.

B is 18.35 meters southeast of *A*, in azmuth 307° 24′, 39.83 meters north-northeast from nearest corner of small shed nearly in line with granite pillar, 25.30 meters north of board fence, and 16.26 meters south of nearest telephone-pole. True bearings: meridianstötten, 13° 35′.1; beacon on small island, 29° 56′.7; flagstaff on hotel, 323° 38′.6; Lutheran church spire, 334° 19′.0.

Hammerfest (Meridianstötten), 1914.—A close reoccupation of Axel S. Steen's station of 1902, due south of meridian column on Fulgenaes Point, 9.42 meters from nearest edge of iron railing surrounding column, 12.05 meters northwest of an angle in high board

EUROPE.[1]

NORWAY—*concluded.*

Hammerfest (*Meridianstötten*), 1915—continued. fence nearly in direction of spire of Lutheran church used as azimuth mark; marked by hole broken in flat stone, 20 by 35 centimeters, which lies imbedded in ground. True bearings: beacon on Fulgenaes Point, 45° 28′.6; Fulgenaes Lighthouse, 48° 22′.5; cupola on Swedish consulate, 276° 44′.0; spire on Catholic church, 307° 10′.7; beacon on mountain, 310° 57′.4; spire on Lutheran church, 322° 19′.0.

Hielmen Island, 1914.—At northeast corner of island, on a butte separated from higher portion of land by a narrow gulch, at an elevation of approximately 50 feet (15 meters), on a large flat ledge. True bearings: Melko Lighthouse, 246° 53′.3; Grundvaag Lighthouse, 321° 08′.0.

Melko Island, 1914.—On southwest end of island, about 10 paces northwest of highest point of this portion of island on a line produced through this summit from town of Hammerfest. To the north, between station and main portion of island, is a low neck where sea breaks across. True bearings: beacon on Haaien Island, 60° 59′.9; Melko Lighthouse, 185° 57′.0; meridianstötten, 299° 37′.9; spire on Lutheran church, 304° 50′.0; staff on Fulgenaes Lighthouse, 306° 48′.6; cairn on mountain, 320° 26′.6; lighthouse on Akkerfiord, 358° 04′.9.

Skibnoes Fiord, Soro Island, 1914.—On a peninsula which juts out into Soro Sund to southward and incloses Skibnoes Fiord, on a point about 60 feet (18 meters) west of edge of hill which at this point is approximately 70 feet (21 meters) high, about 150 feet (46 meters) south of a small but deep gulch. There is a low place where boats land to northward which separates largest part of peninsula from main island. True bearings: Mylingen Lighthouse, 260° 07′.8; Melko Lighthouse, 298° 17′.0; spire of Lutheran church, 302° 04′.4; west gable of white house on Birch Tree Fiord, 313° 13′.6; Grundvaag Lighthouse, 358° 59′.8.

NORTH AMERICA.

CANADA.

Ashe Inlet, Northwestern Territories, 1914.—Station *A* is exact reoccupation of station established by U. S. Coast and Geodetic Survey in 1896, and reoccupied by "Arctic" Expedition in 1909 and 1912. On big island near north shore of Hudson Strait; on east side of inlet, about 23 meters west and 5 meters north of ruins of frame house, about 40 meters north of shore line, and 35 feet (10.7 meters) above high water; marked by drill hole 2 cm. in diameter in rock. True bearings: Tyrrel's beacon, 85° 25′.6; beacon on east side of harbor, 309° 47′.6; beacon on Rabbit Island, 337° 33′.7. A secondary station, *B*, was established 15.25 meters from drill-hole, in range between main station and Tyrrel's beacon.

Coats Island, Northwestern Territories, 1914.—On southeastern shore of Coats Island, about 100 yards (91 meters) north of high-water mark, 10 feet (3.0 meters) above high water, and 1½ miles (2.4 km.) southwest of a ridge or face of beach; marked by spruce stake surrounded by cairn 4 feet (1.2 meters) high. True bearings: rock cropping on ridge (about 3 km.), 212° 05′.0.

Erik Cove, Northwestern Territories, 1914.—On gravel bank at head of cove, 200 meters west of Hudson's Bay Company's post, about midway between the valley walls, 45 meters from high-water mark, and 19 meters from bank of stream that drains the valley; marked by spruce stake. True bearings: opening

NORTH AMERICA.

CANADA—*concluded.*

Erik Cove, Northwestern Territories, 1914—continued. between topmast and mainmast at Hudson's Bay Company's post, 243° 05′.2; gable end of dwelling, 244° 12′.1; Hudson's Bay Company's property post, 107 meters, 273° 47′.3; south corner of white fence at grave, 278° 28′.9.

Eskimo Point, Northwestern Territories, 1914.—On an island which may be Sentinel Island, 600 meters west-northwest from a prominent cairn 2 meters high and 3 meters in diameter; marked by stake driven in sandy soil. True bearing: cairn, 288° 40′.6.

Mistake Bay, Northwestern Territories, 1914.—About one-fourth mile (0.4 km.) north of the head of northernmost inlet of the bay, about 11 feet (3.4 meters) above half-tide, ½ mile (0.8 km.) northwest of conspicuous knoll, 600 feet (183 meters) northwest of a pond, and 23 meters southeast of a cairn 7 feet (2.1 meters) high; marked by cross cut in bed-rock with letters C. I. W. alongside. True bearings: single rock about 14 feet (4.3 meters) high, 1.2 miles (1.9 km.), 50° 46′.6; conspicuous knoll, 304° 59′.5.

Smith Island, Northwestern Territories, 1914.—On west shore of island, about 2 meters above high water, and 7 meters from it; marked by cairn about 1.5 meters high. True bearing: rocky point on summit of small island, 158° 27′.4.

Sydney, Nova Scotia, 1914.—Close reoccupation of station of 1905, 1908, 1909 (marker has been removed in leveling operations to make a baseball-field in park).

CENTRAL AMERICA.

Colon, Sweetwater, Panama, 1915, 1916.—About 2.5 miles (4 km.) due west of Cristobal Channel, on north side of Sweetwater Bay, approximately one-fourth mile (0.4 km.) southwest of station of 1907, 1908, 1909, and 1912, and approximately 100 meters west-southwest of station *B* of 1912, on a low sandy stretch of beach from which line of vision to Colon passes near a shelf of rock on right shore, called by natives "Pelo Bendito," and at right angles to telephone-lines across bay. Station *A* is about 2 meters from water's edge; marked by wooden peg. True bearings: left edge entrance to bay, 226° 19′; left edge Washington Hotel, 247° 13′.8; left wireless-tower, 250° 51′.8; right wireless-tower, 251° 43′.1; right entrance to bay, 253° 45′. This station was closely reoccupied in 1916.

Station *B* is 61.25 meters north of station *A*, about 14 meters from water's edge, 7 meters southeast of a palm, and in direction of *A* are some stumps that were the foundation of a native hut; marked by wooden peg. True bearings: left edge Washington Hotel, 247° 30′.8; center left wireless-tower, 251° 06′.2; center right wireless-tower, 251° 57′.1.

Colon, Washington Hotel, Panama, 1915, 1916.—The station of 1916, which is a close reoccupation of C. I. W. station of 1915, is east of hotel grounds in Bolivar Street near where it ends at sea-wall, and north-northwest of Christ Episcopal Church, 8.97 meters east of eastern wall of hotel grounds at fourth pillar, 20.70 meters southeast of pillar at junction of hotel wall and sea-wall, 23.93 meters southwest of pillar at end of sea-wall, and 41.43 meters northwest of lamp-post at nearest corner of church; marked by large wooden stake. True bearings: signal-pole on top of Washington Hotel, 33° 12′; light on east end of west breakwater, 145° 08′.9; east end of east breakwater, 205° 06′; lamp-post at corner of Christ Episcopal Church, 325° 21′.

[1] See page 286 under Siberia for description of 2 stations in Russia in Europe.

NORTH AMERICA.

CENTRAL AMERICA—*concluded.*

Cristobal, Canal Zone, 1918.—About 1 kilometer east of coaling-station, on main road Colon to Gatun, near quartermaster's garage, about 225 meters directly behind the middle one of three houses numbered 6001, 6003, and 6005, and about 125 meters south-southeast of a small round knoll covered with palms. Two stations were occupied, station *B* being 30.9 meters east by south from station *A*. Not suitable for reoccupation.

NEWFOUNDLAND (INCLUDING LABRADOR COAST.)

Battle Harbor, Labrador, 1914.—Two stations, *C* and *D*, were occupied. *C* is a close reoccupation of station *C* of 1905, in a hollow extending northwest and south-east near center of Battle Island, about 500 feet (152 meters) east of English church, about same distance north of wireless telegraph-station, and about 15 feet (5 meters) east of a natural step in rock about 2 feet (0.6 meters) high, marked by a shallow drill-hole in the rock, and three shallow holes for the tripod legs. True bearings: tower of light-house on Double Island, 318° 36′.1; north gable of wireless station house, 336° 53′.0.

D is 75.9 meters northwest of *C* very nearly in the reversed azimuth of lighthouse on Double Island, on the highest point of Battle Island, 250.4 meters northwest of middle of gable end of wireless operator's house; marked by a 1-inch drill-hole in the solid rock, and also by 3 shallow drill-holes for the tripod legs. True bearings: south gable of two-story house across channel, 67° 30′.1; lone flag pole near edge of island, 118° 10′.7; tower of lighthouse on Double Island, 318° 46′.3; south gable of wireless station house, 333° 25′.3.

Auxiliary stations for reconnaisance magnetic survey to determine possible local disturbances were established; *E*, *F*, *G*, and *H*, were on Battle Island to the north-northeast of stations *C* and *D; I*, *J*, *K*, and *L* were on Big Caribou Island across tickle from Battle Island and about 700 meters south-southwest of stations *C* and *D; M* and *N* were on Great Caribou Island on the isthmus east of Cartridge Bight and about 4 kilometers west-southwest of stations *C* and *D*.

Bay of Islands, Labrador, 1914.—Close reoccupation of C. I. W. stations of 1905 and 1909; at a place called "Riverhead," near mouth of Humber River, about one-fourth mile (0.4 km.) west of Bay of Islands railroad station, 300 yards (274 meters) from wharf of Reid-Newfoundland Company near base of small point of land projecting into the bay, about 39 meters from railroad track, 25 meters from northern extremity of point, and 8 meters from east and west shores.

Boulter Rock, Labrador, 1914.—Two stations, designated *A* and *B*, were occupied on Boulter Rock. *A* is on south end of island, about 10 feet (3 meters) from water's edge, at right-angled intersection of two seams in flat rock. True bearings: northwest end of ridge of house on Old Jeff Island, 100 feet (30.5 meters), 41° 36′.3; south end of ridge of house on summit of Boulter Rock, 173° 09′.1; southwest end of ridge of higher of two houses almost in line on flat island, ¼ mile (0.4 km.), 215° 11′.7; west end of ridge of house on Stag Island, 500 feet (152 meters), 269° 11′.9. *B* is 35 feet (10.7 meters) north of *A*.

Domino, Labrador, 1914.—On east side of entrance to Domino Harbor, about 200 feet (61 meters) above sea, and 11.1 meters south 42° east from a prominent stone cairn. True bearings: cairn on Mustering Point, 1½ miles (2.4 km.), 117° 29′.4; chimney funnel on

NORTH AMERICA.

NEWFOUNDLAND—*concluded.*

Domino, Labrador, 1914—continued.
house near Rocky Point, Spotted Island, 1½ miles (2.4 km.), 149° 38′.6; school flagstaff at Spotted Island Harbor, 198° 13′.4; wireless pole, Domino Harbor, 356° 55′.8.

Gready, Labrador, 1914.—The station of 1881 by S. W. Very was reoccupied; it is now within 7.3 meters of a new house, but there was not time to establish a new station. True bearing: flagstaff, 94° 18′.2.

Great Island, Labrador, 1914.—Near northwest shore of Great Island (about one mile (1.6 km.) northwest of Battle Island), 7 feet (2.1 meters) east of large rift in rock, and about 50 yards (46 meters) south-east of sea end of rift; marked by shallow cross cut in solid rock. True bearings: gable of house on opposite shore of Lewis Sound, 140° 33′.9.

Green Island, Labrador, 1914.—On the cliff on east shore of island, 22 meters southeast of a cairn, 2.5 meters northwest of a rift in rock, and in range between the cairn and station Battle Harbor *D*. True bearing: Battle Harbor *D*, 286° 13′.5.

Gull Rocks, Labrador, 1914.—Two stations, designated *A* and *B*, were occupied on larger of two rock islands in Lewis Sound, 3 miles (4.8 km.) northwest of station Battle Harbor *D*. *A* is in middle of 15-foot (4.6 meters) rift in solid rock, 20 feet (6.1 meters) north-west of a cairn built on highest part of island. *B* is 1.6 meters southeast of cairn, in range between cairn and station Battle Harbor *D*. True bearing: Battle Harbor *D*, 301° 34′.0.

Hopedale, Labrador, 1914.—On point of land about 200 yards (183 meters) east of the Moravian mission, near highest point of exposed rock. True bearings: base of pole of beacon west of mission, 94° 44′.2; pinnacle of Moravian church, 104° 23′.9; beacon on hill, 136° 20′.5.

Port Burwell, Labrador, 1914.—Practical reoccupation of station established by Gordon and Stupart in 1884-85, and reoccupied by British Navy in 1905, and by "Artic" Expedition in 1909 and 1912; on west shore of Port Burwell, on neck of land between harbor and a salt-water pond; covered by wooden beacon anchored by mass of broken rock inside the structure. Two points, designated *A* and *B*, were occupied in 1914. *A* is 3.8 meters from beacon and in line between it and a low beacon on other side of harbor. True bearings: beacon at west end of pond, 75° 05′.3; beacon on brow of hill on east end of point of land, 219° 48′.4; low beacon east of point of land, 225° 55′.3.

B is about 70 meters south of *A;* marked by charred stick covered by cairn of stone 1.5 meters high. True bearing: low beacon on rock east of point of land, 218° 10′.8.

Sangmijok, Labrador, 1914.—On south shore of raised beach on neck of land between 2 hills, 12 feet (3.7 meters) above high water, and 5 feet (1.5 meters) south 78° west (magnetic) from a cairn 4 feet (1.2 meters) high; marked by charred stick projecting 6 inches (15 cm.) above ground.

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Applegarth, Lower Hooper Island, Maryland, 1919.—In the middle of graded road running southward from present shore line toward the schoolhouse, about 20 paces south of shore, which is rapidly advancing under action of the water. Line to Hooper Straits Light-house passes across small landing wharf immediately in front of crab cannery. Marked by oak tent peg. True bearings: top of schoolhouse cupola, 12° 50′.8;

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Applegarth, Lower Hooper Island, Maryland, 1919—cont'd. Hooper Island Lighthouse, 95° 41′.6; Hooper Straits Lighthouse, 292° 25′.6.

Austin, Esperanza Schoolhouse, Texas, 1918.—About 4 miles (6.4 kilometers) north of the state capitol, near southeast corner of grounds of Esperanza schoolhouse, 42 feet (12.8 meters) from east fence, 55 feet (16.8 meters) from south fence and 81 feet (24.7 meters) from southeast corner of small frame schoolhouse. True bearings: central spire main building at University, 0° 38′.0; central spire St. Edward's College, 7° 27′.6; center of chimney, Ullrich farm house, 14° 20′.3.

Barren Island, Maryland, 1919.—On western shore of uninhabited island, northern end of which is marshy and rapidly being cut away by water, about 200 yards (183 meters) south of northern extremity of land, 26 paces from line of nearest pine trees in grove to southeast, and 7 paces east of bank marking high water. True bearings: red beacon at entrance to channel, 177° 03′.0; black beacon at entrance to channel, 203° 27′.0; station at Charity Point, 260° 30′.9.

Brewton, Alabama, 1918.—Exact reoccupation of U. S. Coast and Geodetic station of 1911, in north central section of field owned by Mr. Lovelace, about half mile north of railroad station, three blocks east of Belleville Avenue and 1½ blocks north of corner of Belleville Avenue and McClellan Street, in middle of unused street, 121.5 feet (37.04 meters) from corner of fence to northwest, 87.6 feet (26.7 meters) from corner of fence to northeast, and 280 feet (85.3 meters) from fence to west. Marked by a granite post 9 by 9 by 30 inches (23 by 23 by 76 cm.) projecting about 3 inches (8 cm.) above surface of ground and having a Coast and Geodetic Survey plate in top. True bearings: right edge of smokestack, 3° 59′.0; small church spire, 328° 00′.2.

Broadmoor, Colorado, 1918.—Near south edge of Stratton Park about 600 feet (183 meters) east-southeast of cottage occupied by Mr. Evans, superintendent of park, about 3 feet (1 meter) north of middle of pine tree which stands about 200 feet (61 meters) south of fence along road leading to Broadmoor Hotel, and about 100 feet (30 meters) east of small gate in this fence. True bearing: top of tower on Broadmoor Hotel, 256° 49′.1.

Cascade, Colorado, 1918.—In village of Cascade, about three-eighths mile (0.6 km.) east of railway and creek, on northern edge of straight street leading northeasterly from large summer hotel on west side of railway and creek, 241.0 feet (73.46 meters) northeast of northeast corner of boarding-house, "Easthome." True bearings: northeast corner of "Easthome," 38° 06′.6; flagpole on summer hotel, 66° 26′.3; southeast end of ridge of house, 69° 20′.8.

Cedar Point, Maryland, 1919.—On narrow sandbar joining lighthouse to mainland, 5 paces from high-water line along south side of bar, 20 paces from high-water line on opposite side, 342 paces southwest of concrete wall built up around lighthouse buildings, about 8 feet (2 meters) west of a stump near high-water line, about 10 paces northeast of nearest of 3 pine trees in a row parallel to beach, continuation of which passes just north of station, and about 100 yards (91 meters) southwest of eastmost trees on bar. True bearings: right edge of brick chimney on farmhouse, 116° 32′.8; Cove Point Lighthouse, 174° 29′.2; center of light, Cedar Point Lighthouse, 226° 30′.1; Hooper Island Lighthouse, 293° 08′.4; Point No Point Lighthouse, 348° 33′.6.

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Cedar Point Hollow 1, Maryland, 1919.—On west shore of Chesapeake Bay, on stretch of shore-line known locally as Cedar Point Hollow, between Cedar Point and Point No Point, about 6 miles (10 km.) south of Cedar Point Lighthouse, on southern end of one of several abrupt clay banks, about one-fourth mile (0.4 km.) southeast of two-story frame farmhouse standing back of cleared field open to shore, and just south of extended line of south side of house, about half mile (0.8 km.) south of house standing close to beach, near extremity of narrow ridge lying between bay and a marshy inlet among some scrubby cedars. True bearings: right edge of right chimney on house near beach, 146° 11′.8; Cedar Point Lighthouse, 185° 29′.7; Hooper Island Lighthouse, 245° 42′.9.

Cedar Point Hollow 2, Maryland, 1919.—Most southerly of three Cedar Point Hollow stations, in north edge of an old field, about one-fourth mile (0.4 km.) north of a yellow farmhouse, 80 paces south of north boundary of old field defined by a fence overgrown with small trees and brush, and a drain ditch discharging onto beach, 35 feet (11 meters) south of east apple tree of three apple trees, 70 feet (21 meters) southwest of west apple tree, on a line with middle apple tree and an old barn on adjoining farm, and about 20 feet (6 meters) west of edge of clay bank about 8 feet (2 meters) high. True bearings: east gable of barn, half mile (0.8 km.), 124° 13′.0; Cedar Point Lighthouse, 176° 42′.1; Hooper Island Lighthouse, 231° 29′.8; Point No Point Lighthouse, 317° 23′.0; lightning rod on east gable of house, 349° 45′.8.

Cedar Point Hollow 3, Maryland, 1919.—Near northern end of highest of several bare clay banks along shore, about one-fourth mile (0.4 km.) north of large farmhouse standing on highest part of bluff, about 150 feet (46 meters) northeast of small bungalow farmhouse, 42.5 feet (12.95 meters) north of wire fence along north side of farmhouse, 66 feet (20.1 meters) northwest of end post of fence standing on top of bank above shore, 40.5 feet (12.34 meters) south of center of a large cedar tree about 2 feet (0.6 meter) in diameter standing near head of a short ravine, and 51 paces east of line of front of bungalow farmhouse. True bearings: northeast corner of bungalow, 59° 13′.0; northeast corner of old barn, 400 feet (122 meters), 103° 05′.1; gable of nearest of three bungalows, 2 miles (3 km.), 171° 37′.5; Cedar Point Lighthouse, 198° 16′.7; Hooper Island Lighthouse, 261° 34′.0; east edge of east chimney of large farmhouse, 356° 25′.4.

Charity Point, Maryland, 1919.—On extreme southern end of Meekin Neck, northeast of Barren Island, near channel leading to Fishing Creek bridge which connects mainland to Upper Hooper Island, on flat oyster-shell beach at about high-water mark, at extreme south end of land, just at west edge of small marsh extending northward into bush. True bearings: Hooper Island Lighthouse, 6° 04′.2; magnetic station on Barren Island, 80° 34′.0; red beacon at channel entrance, 101° 02′.8; black beacon at channel entrance, 102° 47′.1; church spire in Fishing Creek village, 338° 55′.4; chimney of burned house on point west of Fishing Creek village, 351° 56′.7.

Cheltenham, Maryland, 1915, 1917.—Observations were made on pier B_i of Cheltenham Magnetic Observatory of United States Coast and Geodetic Survey; this is same station as that occupied in 1908, 1910, and 1913. Declination observations were also made in 1915 at an outside station, designated *O*, 35.9 feet (10.94 meters) nearly due east of observatory declinometer pier in east wing of absolute observatory.

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Cheltenham, Maryland, 1915, 1917—continued.
Inclination observations were also made at station, designated *(EI)′*, on a non-magnetic framework attached to pier in east wing of absolute observatory upon which observatory inductor is permanently mounted.

Corona, Colorado, 1918.—On mountain side east of railroad station, about 350 yards (320 meters) southeast of east door of train-shed near entrance to lunch room, 42 feet (12.8 meters) south of center of leveled area near shelter for meteorological instruments, south of path leading to pole on summit of mountain, somewhat less than halfway up mountainside from railroad station; marked by a cross chiseled in a stone firmly imbedded in ground. True bearings: middle of top of ventilator of snow-shed, three-quarters mile, 30° 21′.8; southeast edge of hotel, half mile, 133° 19′.2; highest point of highest gable of hotel, half mile, 134° 33′.1.

Cove Point Lighthouse, Maryland, 1919.—On level low sand area south of lighthouse, approximately in a line joining top of Cove Point Lighthouse with Cedar Point Lighthouse, 166 paces south of steel tower near lighthouse, 72 paces to high-water mark on east and 49 paces to high-water mark on south, 32 paces southwest of small cedar tree, and 81 paces south-southeast of a small lagoon. True bearings: outside corner of piling at Cove Point steamer landing, 42° 57′.5; spire on Cove Point Lighthouse, 172° 22′.0; south end of timber on Barren Island, 304° 56′.2; Hooper Island Lighthouse, 337° 17′.8; Cedar Point Lighthouse, 352° 43′.4.

Cow Mountain, Colorado, 1918.—About the 10,500-foot (3,200-meter) level on northern slope, about 100 feet (30 meters) west of an abandoned mine-shaft. True bearings: summit of Rhyolite Mountain, 107° 43′.0; triangulation signal on Trachyte Mountain, 127° 04′.2; garage on Pikes Peak, 205° 16′.9.

Derring Harbor, Shelter Island, New York, 1914.—The station of 1910 and 1913 was reoccupied, over north stone of a true meridian line, on bluff at southeast end of Derring Harbor, in a wooded tract belonging to Prof. Charles Lane Poor, of Columbia University, 15 meters from edge of bluff, 57.6 meters from south meridian stone, 4.65 meters south of an oak tree, 7.58 meters east of a chestnut tree, 5.45 meters north of an oak tree, 10.05 meters west of an ash tree, measurements in each case being to copper nails driven in trunks of trees. The meridian stone which marks station is of granite, 6 by 6 inches (15 by 15 cm.) on top and about 4 feet (1 meter) long, lettered on top "C. I. W. 1910" and has half-inch hole about 2 inches deep at center to mark precise point. True bearings: tip of tower of Union Chapel, Shelter Island Heights, 94° 41′.1; middle of top of tall chimney, Greenport Water Works, 130° 23′.5; flagstaff at Greenport schoolhouse, 144° 18′.0; middle of top of tall chimney, Greenport Hygeia Ice Co., 151° 18′.6; spire of First Baptist Church, 154° 15′.3.

Dutch Harbor, Alaska, 1915.—On Amaknak Island, on medium high ground north of village of Dutch Harbor, north of Unalaska and U. S. Navy wireless stations, about 300 yards (274 meters) northwest of pier extending eastward into harbor at about middle of village, in line with wireless station and large white house in Unalaska known as "Jesse Lee Home," and in line with edge of bay near pier and a grass-covered water-tank on knoll; station *A* is marked by 10-inch post projecting about 1 foot (30 cm.) and having on its top a circular brass plate inscribed C.I.W.1915 with a small drill-hole to mark exact spot. True bearings: peak east of Captains Bay, 12° 44′.5; upper knob of volcano slope, 131° 15′.5; beacon on spit, 252° 50′.4; pole on C. & G. S. station near water-tank, 328° 54′.2; center gable of Jesse Lee Home, 344° 24′.4.

Station *B* is 34.2 meters north of *A* in line from center gable of Jesse Lee Home extended through station *A*. True bearings: upper knob of volcano slope, 131° 10′.4; beacon on spit, 254° 04′.7; pole over C. & G. S. station, 329° 47′.4; center gable of Jesse Lee Home, 344° 24′.4; west gable of Jesse Lee Home, 344° 45′.0.

The *C. & G. S.* station of 1913 was reoccupied. On Amaknak Island southeast of village near crown of hill, about 164 feet (50 meters) south of sod-covered water-tank, 98 feet (30 meters) south of observatory azimuth mark; marked by square dressed stone with a drill-hole in top. True bearings: point on mountain, 76° 44′.0; observatory azimuth mark, 180° 00′.3; white post near end of island, 341° 17′.8.

Fishers Island, Connecticut, 1917.—On Fort F. G. Wright Military Reservation, on crest of first steep rise of land north of gravel spit forming entrance to Silver Eel Pond, the landing place for vessels, 35 feet (10.7 meters) above high-water mark, 20 feet (6.1 meters) from edge of bluff, and 9 feet (2.7 meters) southeast of large boulder, 4 by 6 feet (1.2 by 1.8 meters), projecting 2 feet (0.6 meter) out of ground. True bearings: Race Rock Lighthouse, 38° 54′.6; New London Harbor Lighthouse, 142° 26′.2; Fishers Island Fort flagstaff, 341° 13′.0.

Gillett, Colorado, 1918.—On vacant lot southeast of old hotel, about 50 yards (46 meters) south of center of street running south, about 30 yards (27 meters) from edge of stream, near foundation of house which has been removed, about 150 paces east of switch-stand on railway. True bearings: top of tank at Altman mine, 4 miles (6 km.), 15° 49′.9; tip on railway water-tank, 19° 56′.0; switch-stand, 93° 57′.1; summit of Rhyolite Mountain, 92° 40′.8; northeast corner of railway station, 122° 11′.7; trigonometric signal on Trachyte Mountain, 304° 10′.6.

Glen Cove, Colorado, 1918.—On point of moraine about on level with roofs of several houses, about 300 feet (91 meters) northwest of Glen Cove Inn. True bearings: edge of rock, 6 to 8 miles (10 to 13 km.), 216° 03′.6; northwest end of ridge of Glen Cove Inn, 305° 54′.8; northwest end of ridge of dwelling in Glen Cove, 340° 38′.3.

Goat Island, California, 1916.—Station *A* is a reoccupation of U. S. Coast and Geodetic Survey station of 1904 and C. I. W. station of 1905 and 1908, on military reservation, near center of small plateau on western slope of hill at eastern end of island, slightly south of line from top of hill to smokestack at naval training-station, and 48 feet (14.6 meters) north of line of two flagpoles, one on highest point of island and other on southern part of lawn at officers' quarters; marked by a rough stone about 6 inches (15 cm.) square with a hole in top. True bearings: tip of east radiomast, 44° 58′.7; tip of west radiomast, 62° 17′.6; right edge of chimney of house No. 8, 74° 02′.4; lighthouse on McDowell Point, 85° 56′.2; tip of lighthouse on Alcatraz Island, 104° 03′.4; campanelli at University of California, 234° 36′.7; center of gable at Western Pacific ferry, 300° 07′.1.

Station *B* is 64 meters west of *A* in line from station to lighthouse on McDowell Point. True bearings: top of east radiomast, 43° 47′.7; lighthouse on

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Goat Island, California, 1916—continued. McDowell Point, 85° 56′.2; lighthouse on Alcatraz Island, 104° 07′.7; campanelli, 234° 40′.2; center of gable on Western Pacific ferry, 299° 55′.0.

Goldendale, Washington, 1918.—Three stations were occupied in city park, about half mile (0.8 km.) north of town. Station *A* is 153.5 feet (46.79 meters) east of wire fence bounding park on west, 122.5 feet (37.34 meters) north of wire fence between park and cemetery, 94.5 feet (28.80 meters) southeast of south corner of blockhouse, and 109 feet (33 meters) southeast of flagpole which stands 67 feet (20 meters) southwest of west corner of blockhouse, and 76 feet (23 meters) east of west fence of park; marked by pine peg. True bearings: flagpole on court-house grounds, 3° 30′.7; flagpole on court-house tower, 4° 05′.0; pole near Majestic Hill, 45° 33′.2; Mount Hood, 53°.9; flagpole near blockhouse, 134° 03′; south corner of blockhouse, 176° 05′; U. S. Coast and Geodetic Survey station, 220 yards (201 meters), 270° 03′.2.

Station *B* is 37.4 feet (11.40 meters) south of station *A* on line to flagpole on court-house tower, near north side of wagon trail leading from park entrance to city water reservoir, in group of large pine trees, 43 feet (13 meters) northeast of pine tree south of wagon trail, 6.7 feet (2.04 meters) east of pine tree, 7.7 feet (2.35 meters) southeast of pine tree, 26.5 feet (8.08 meters) southwest of pine tree, and 7.6 feet (2.32 meters) west of pine tree.

Goldendale, C. & G. S., 1914, Washington, 1918.—Station is a reoccupation of U. S. Coast and Geodetic Survey station of 1914, in city park, about half mile (0.8 km.) north of town, about 250 yards (229 meters) east of road, about 300 feet (91 meters) west of lower reservoir, 121.3 feet (36.97 meters) north of cemetery fence, at a point 221 feet (67.4 meters) east of stone marked Lester V. Thomas which stands 33 feet (10.1 meters) south of fence, about 50 feet (15 meters) west of ditch running from reservoir and 36 feet (11 meters) south of center of cart road to reservoir; Mount Hood is seen approximately in line with small stone marked Mary Brown standing about 25 feet (8 meters) south of Thomas stone; marked by bronze station-mark set in cement. True bearings: Presbyterian church spire, 12° 25′.2; flagpole near court-house, 12° 59′.5; Lester V. Thomas gravestone, 57° 26′.4; station *A*, 90° 03′.3.

Great Gull Island, New York, 1917.—On military reservation in small garden, about one-third length of island west of eastern end, 20 feet (6.1 meters) above high-water mark, and 18 feet (5.5 meters) from edge of bluff on south shore. True bearing: Little Gull Lighthouse, 245° 57′.0.

Green Mountain Falls, Colorado, 1918.—About 200 yards (183 meters) east-southeast of railway station on Colorado Midland Railway, about 70 yards (64 meters) northeast of stream, on dump thrown out of small excavation just east of a larger excavation, about opposite point on stream where it is joined by brook coming out of mountains past hydo-electric plant. True bearings: west vertical edge of hydro-power-house on hillside, 49° 23′.2; flagpole on school-house, 102° 19′.4; east gable of railway station over ticket office, 118° 27′.0; flagpole on pavilion on mountain, 128° 39′.4; summit of peak near railway, 2 miles (3 km.), 328° 34′.4.

Greenport, A, Long Island, New York, 1914.—Reoccupation of United States Coast and Geodetic Survey station of 1904, and C. I. W. station *A* of 1909, 1910, and 1913. In northern part of school grounds just south of row of large maple trees; marked by marble post lettered on top U.S.C.& G.S.1904, with a drill-hole at center marking precise point. True bearings: spire of Presbyterian church, 203° 22′.2.

Griswold Landing, A, Connecticut, 1917.—Near end of northern pier for Griswold Hotel, across Thames River from New London, near point at east side of entrance to New London Harbor, on macadamized road leading to pier, 41.5 feet (12.65 meters) back from outer edge of pier and midway between its ends. True bearings: New London Ledge Lighthouse, 0° 15′.6.

Halfway, Colorado, 1918.—About 250 paces south of and up Dark Canyon from Halfway House on Pikes Peak cog railway, about 50 paces south of small flood gate on brook in Dark Canyon, 82.3 feet (25.09 meters) south-southwest of nearly rectangular boulder about 6 feet (2 meters) high and 7 or 8 feet (2 or 3 meters) long and wide, and 44.8 feet (13.66 meters) northeast of spruce tree about 18 inches (46 cm.) in diameter. True bearings: Pilot Knob, 6° 14′.7; south end of ridge of dormer window, 182° 37′.0; spruce tree on slide, north side of Engelmann Canyon, 191° 42′.0.

Hampton, Virginia, 1917.—Exact reoccupation of U. S. Coast and Geodetic Survey station of 1912, in southeast corner of grounds of National Soldiers' Home, on sea-front, in front of hospital, about 18 paces south of driveway, and 15 paces from sea-wall measured along a line through station to central tower of hospital, about 200 feet (61 meters) west of sea-wall along inlet at southeast boundary of grounds; marked by limestone post 6 by 6 by 30 inches (15 by 15 by 76 cm.), projecting slightly above ground, with brass station marker in top, True bearings: flagpole, above trees, 115° 38′.1; finial on cupola at center of hospital, 192° 02′.5; spire on church at Fortress Monroe, 299° 35′.3; finial at extreme left of Chamberlain Hotel, 307° 27′.0.

Holland Island, Maryland, 1919.—Near southern extremity of island, on a piece of bare ground formerly intersection of a short road to beach with main road running parallel with beach, about 30 feet (9 meters) east of present high-water line along beach, about 45 feet (14 meters) southeast of an old shed, and about 175 paces along road leading south from nearest dwelling-house, rear portion of which has been washed down by tides. True bearings: Holland Island Bar Lighthouse, 3° 42′.0; church spire on Holland Island, 212° 41′.7.

Iron Mountain, Colorado, 1918.—On summit of mountain, as far toward northern edge of area as precipitous character of sides of mountain permits. True bearings: Summit House, 85° 06′.9; box on Eagle Cliffs, 110° 08′.4; magnetic station Manitou, *A*, 162° 54′.6; center of "V" in Cave of Winds (sign painted on entrance to cave), 167° 33′.6.

Jones Park, Colorado, 1918.—In small basin or clearing in timber called Jones Park, which is in northeast corner of Teller County, and on Bear Creek, about one-eighth mile (0.2 km.) from trail junction on county line, about 15 feet (4.6 meters) south of wagon road from Colorado Springs to Lake Moraine, 58.5 feet (17.8 meters) from northwest corner of wire fence inclosure, and about 60 feet (18.3 meters) north of creek. True bearings: nearest end of ridge of log house, about 100 feet (30.5 meters), 15° 26′.7; post, about 200 feet (61.0 meters), 17° 36′.9; nearest end ridge of out-house, about 100 feet (30.5 meters), 34° 58′.3; stump of dead pine on summit of mountain,

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Jones Park, Colorado, 1918—continued. about 1 km., 292° 02′.5; northwest corner of fenced inclosure, 58.5 feet (17.8 meters), 295° 53′.

Lake Moraine, Colorado, 1918.—Station *A* is on northern shore of Lake Moraine, 30 feet (9 meters) northwest of water's edge, 125.4 feet (38.22 meters) east of northeast corner of keeper's lodge. True bearings: northeast corner of Kinikinic Lodge, 88° 04′.1; northeast corner of keeper's lodge, 121° 35′.3; middle of platform Pikes Peak tower, 124° 01′.1; northeast corner of eaves of barn, 216° 38′.6.

Station *B* was selected for eclipse observations, about 85 yards (78 meters) north-northeast of keeper's lodge, about 160 feet (49 meters) northwest of cabin at edge of lake, and about 25 feet (7.6 meters) above surface of lake. True bearings: north end ridge Kinikinic Lodge, 39° 42′.4; monument on Camerons Cone, 244° 41′.8.

Lakin, C. & G. S., Kansas, 1918.—Exact reoccupation of U. S. Coast and Geodetic Survey station of 1904. In Lakin cemetery one mile (1.6 km.) northeast of town, near south side of cemetery in main driveway extending north and south, 41.1 and 47.4 feet (12.53 and 14.45 meters) southwest of northwest and southeast corners respectively of Beaty tomb, 21.6 feet (6.58 meters) west of northwest corner of Whinery gravestone, 17.7 feet (5.40 meters) east of northeast corner of Susannah Swanick gravestone, and 45.1 feet southeast of southeast corner of James Oscar Martin gravestone; marked by cement post lettered 1904. True bearings: west edge of water-tank in Lakin, 22° 38′.8; spire on Methodist church, 34° 44′.7; cupola on schoolhouse, 41° 58′.2; southwest corner of farmhouse, 175° 52′.7.

Lakin, Eclipse, 1918.—Near home of Mr. Pittinger, 3½ miles (5.6 km.) south and 2½ miles (4.0 km.) west of Lakin, 68.2 feet (20.79 meters) northwest of electric power pole at north side of road, 103.8 feet (31.64 meters) northeast of locust tree near southwest corner of field, 58.9 feet (17.95 meters) southeast of southeast corner of building used as variometer station during eclipse; marked by brass-bound tripod peg. True bearings: southeast corner of pumping plant, section 17, 16° 34′.5; southeast corner of Mr. Pittinger's house, 87° 06′.8; southeast corner of building used as variometer station, 110° 13′.3; middle of chimney on farmhouse, 244° 50′.1.

Langley Field, Virginia, 1917.—Four stations, designated *A, B, C,* and *D*, were occupied, on aviation field. Station *A* is about 300 yards (274 meters) north of temporary airplane hangars, nearly on line from hangar No. 3 to west one of two silos about 1 mile (1.6 km.) distant on old Kimberley farm, now part of Langley Field, and in line between south pair of white poles marking measured one-mile course and south end of brick barn near building now used as temporary headquarters, about 45 paces west of well with cement curb, and west of road along which a trunk sewer is laid. True bearings: light in north gable of hangar No. 3, 0° 59′.2; flag on tower back of hangars, 25° 07′.8; right north mile range-pole, 163° 25′.3; tip of westmost of 2 silos, 180° 49′.0; tip of eastmost of 2 silos, 181° 19′.4; west gable of red barn used as temporary headquarters, 298° 23′.8.

Station *B* is directly in front of hangar No.2, in a line from gable of hangar No. 3 to top of left silo on Kimberley farm, just at edge of whitewashed line marking limit of flying field. Station *B* is south meridian point of meridian line for testing of airplane compasses; marked by cement platform upon which

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Langley Field, Virginia, 1917—continued. machines are swung. True bearing: top of left silo on Kimberley farm, 180° 49′.0.

Station *C* is at northeast corner of seaplane hangars, about 15 yards (14 meters) northeast of northeast corner of hangar No. 4, about 20 feet from water's edge. True bearing: signal-post in water, 10° 16′.0.

Station *D* is on concrete runway from entrance to hangar No. 3 to water, on line from station *C* to signal-post in water south of hangars. True bearing: signal-post in water, 10° 16′.0.

Manitou, A, Colorado, 1918.—On a plateau north of Cliff House and south of Serpentine Road to Cave of the Winds, on grounds in rear of Williams Cottage, west of Williams Cañon, 148.5 feet (45.26 meters) northeast of northwest corner of cottage, 49.5 feet (15.09 meters) south of a line of posts at north of premises, 84.2 feet (25.66 meters) southeast of southwest corner of fence around small cottage to northeast, nearly in line with east end of Williams Cottage, in line with a point 2 feet (0.6 meter) west of fence corner and Davis house south of Manitou at foot of Iron Mountain, and in the line from gate near southwest corner of small cottage to center of middle one of 3 wooden railway-trestles on Colorado Midland Railway. True bearings: split in boulder across cañon, 52° 37′.2; box on Eagle Cliffs, 82° 04′.0; cupola on Davis house at foot of Iron Mountain, 336° 17′.6; ball on cupola of schoolhouse, 338° 19′.1.

Middle Hooper Island, Maryland, 1919.—On northern end of island, about 30 yards (27 meters) east of main shell road running through island about 1 mile (1.6 km.) south of bridge connecting Upper and Middle Hooper islands, about 50 yards (46 meters) northeast of shed at west edge of road, used for storing fishing-nets, in line with shed and Point No Point Lighthouse, and about 300 yards (274 meters) south of house of Henry Travers; marked by a wooden stake. True bearings: Hooper Island Lighthouse, 66° 07′.4; right tangent chimney of Henry Travers's house, 146° 24′.7; left tangent chimney of Mrs. Minnie Travers's house, 358° 38′.2.

Midland, Colorado, 1918.—About 1.5 miles (2.4 km.) north of Midland station on Colorado Midland Railway, about one-fourth mile (0.4 km.) north of third highway crossing, in a pasture about 100 feet (30 meters) east of fence along highway, 15 feet (4.6 meters) west of deep washout, and directly in line with center line of 18-inch (46-cm.) galvanized-iron culvert under highway. True bearing: railroad crossing warning at third crossing from railway station, 358° 23′.0. Approximate bearings: summit of Rhyolite Mountain, 3° 06′; culvert under highway, 98° 58′; fence corner near highway, 181° 07′.

Mountain View, Colorado, 1918.—At right of railway to summit of Pikes Peak, about 1,000 feet (305 meters) south of station at Mountain View, on a bare sandy ridge reached by following cog-road down to point where a trail crosses a little stream, thence following trail over a low ridge, and across a deeper ravine, where it turns sharply upward toward left, in line with turn of cog-road around Windy Point and a point a little above railway station. True bearings: east gable of Mountain View station, 26° 32′.8; Summit House, center of upper platform, 99° 37′.7; large dead tree on Cameron Cone, seen just over summit of a low hill, 275° 41′.9; Pilot Knob, 313° 07′.6; notch in rocks in sky-line of saddle, 345° 52′.9; summit of Bald Mountain, between two rocks slightly west of summit, 354° 39′.0.

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Mount Manitou, Colorado, 1918.—Two stations were occupied. Station, *Eagle Cliffs,* is on salient jutting down to Eagle Cliffs Platform, about 200 feet (61 meters) northwest of platform, just above trail leading from Eagle Cliffs to Crest Crags, between 2 large masses of rock 15 to 20 feet (5 to 6 meters) high. True bearings: cleft in rocks showing against sky-line, 183° 11′.2; conical object on top of hill showing against sky, 203° 07′.2.

Station, *Fremont Experiment Station,* is about 300 feet (91 meters) west of House No. 2 of Fremont Experiment Station, on gravel pit on north side of road; marked by tent-peg. True bearings: southeast end of ridge of dwelling, 273° 21′.8; edge of rock showing against sky, 275° 39′.6; flagpole, 281° 45′.6.

New London, Connecticut, 1917.—Reoccupation of C. and G. S. station of 1904 and 1910. On grounds of city almshouse, about 1 mile (1.6 km.) west of city hall, in pasture about 80 by 85 yards (73 by 78 meters) full of granite boulders, on south side of east-west road extending through almshouse grounds, 600 feet (183 meters) west of almshouse water-tank, 59 feet (18.0 meters) south of west post of gate leading into pasture, 44.6 feet (13.6 meters) from nearest point of north wall of pasture inclosure, and 222.8 feet (67.9 meters) north of south meridian stone, 6 by 6 by 27 inches (15 by 15 by 69 cm.), projecting about 6 inches (15 cm.) above ground; marked by north stone, 6 by 6 by 30 inches (15 by 15 by 76 cm.), with top slightly below level of surface of ground, both stones being lettered U. S. C. S. True bearings: weather-vane on private barn, 180° 32′.4; gable on house, 346° 49′.8 (from C. and G. S. azimuths); prominent flagpole, 190° 31′.6.

Ocean Beach, New London, Connecticut, 1917.—On long rocky point of land covered with small bushes, south of and separated from summer resort by inlet from Long Island Sound, 1 mile (1.6 km.) southwest of New London Harbor Lighthouse, 45 feet (13.7 meters) from extreme southeast end of point, and 13.5 feet (4.11 meters) northeast of large solitary boulder about 3 by 6 feet (0.9 by 1.8 meters), projecting about 2.5 feet (0.8 meter) above ground. True bearings: Little Gull Lighthouse, 2° 15′.0; New London Harbor Lighthouse, 216° 06′.3; New London Ledge Lighthouse, 264° 51′.6; Race Rock Lighthouse, 325° 50′.6.

Pikes Peak, Colorado, 1918.—Three stations were occupied. Station *A* is 66.3 feet (20.21 meters) west of automobile road, on summit of Pikes Peak, where it is running in a northerly direction, on last curve to auto-station; marked by tent-peg. True bearings: rock on mountain, about 25 to 40 miles (40 to 64 km.), 174° 06′.0; U. S. Coast and Geodetic Survey triangulation station, 263° 49′.4; right stanchion of handrail on observation-tower platform, 271° 17′.4; left edge of auto-station, 279° 38′.4; right edge of auto-station, 287° 43′.7.

Station *B* is on summit of Pikes Peak, about 300 feet (91 meters) northwest of tourists' observation tower, about 10 or 15 feet (3 or 5 meters) southwest of a line passing through southeast and northwest corners of tower platform. True bearings: southeast corner of auto-station, 43° 54′.0; northwest corner of auto-station, 51° 03′.0; U. S. Coast and Geodetic Survey triangulation point, 62° 48′.3; rock on mountain, 173° 52′.4; northeast corner of observation-tower stonework, 306° 10′.3.

Station *C* is about 350 feet (107 meters) northeast of tourists' observation tower, and about 30 feet (9 meters) lower than summit, on a small flat on salient jutting down towards northeast. True bearings: southeast corner of hotel, 26° 14′.8; northwest corner

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Pikes Peak, Colorado, 1917—continued.
of hotel, 42° 39′.5; stanchion of railing around memorial, 103° 22′.3; rock on mountain, 173° 41′.8.

Pine Island, Connecticut, 1917.—On uninhabited island, just east of entrance to New London Harbor, about midway of western end of island, on bluff 50 feet (15.2 meters) above high-water mark, 30 feet (9.1 meters) east of edge of bluff, and 10 feet (3.0 meters) east of large boulder about 3 by 6 feet (0.9 by 1.8 meters), projecting about 4 feet (1.2 meters) out of ground. True bearings: end piling on pier at Osprey Beach, on west side of entrance of New London Harbor, 94° 25′.2; New London Harbor Lighthouse, 100° 59′.7; Race Rock Lighthouse, 351° 38′.8.

Point Lookout, Maryland, 1919.—On shore of Chesapeake Bay, about 1 mile (1.6 km.) north of Point Lookout Lighthouse, on a cleared area, about 50 feet (15 meters) west of high-water line, 21.5 feet (6.55 meters) south of most southerly of a group of about 20 small cedars at water's edge near remains of a station for tarring fish-nets, and about 30 paces from high-water line measured through cedars in direction of Point No Point Lighthouse; marked by an oak tent-stake. True bearings: center of Point Lookout Lighthouse, 6° 58′.9; north gable end of farmhouse near bank of Potomac River, 49° 17′.1; Point No Point Lighthouse, 196° 44′.1.

Point No Point, Maryland, 1919.—On point midway between sand beach and several trees, 50 yards (46 meters) west of high-water mark; marked by a stake in very loose sand. True bearing: Point No Point Lighthouse, 296° 12′.6.

Raspberry Mountain, Colorado, 1918.—On top of mountain, on prominent high point of serrated narrow ridge, about one-eighth mile (0.2 km.) south of highest point. True bearings: pole on highest point, 200° 35′.3; outer edge of automobile road line, 302° 59′.7; sharp point on mountain, 346° 15′.6; rock on Sentinel Mountain, 350° 16′.2.

San Diego, California, 1916.—Close reoccupation of C. I. W. station *III* of 1905 and 1906, on north shore of San Diego Bay, on a low beach northwest of Dutch Flat, and near southwest corner of Point Loma golf-club course, 300 feet (91 meters) north 23½° east of a triangulation signal on sand spit, and 8.6 meters east of a concrete tide-post; marked by blue-gum peg 18 inches (46 cm.) long and 1 inch (3 cm.) square, left within 1 inch (3 cm.) of surface of ground, on either side of which are two hardwood slats projecting 2 feet (0.6 meter) above ground and driven 3 feet (0.9 meter) into the soil, each slat 2 inches (5 cm.) wide and 1 inch (3 cm.) thick. True bearings: triangulation mark, 23° 29′; old lighthouse, Point Loma, 23° 52′.3; low dome on School of Theosophy, 63° 32′.3; exposition tower, 276° 52′.2; south tower Coronado Hotel, 336° 54′.8.

San Rafael, California, 1916.—Exact reoccupation of U. S. Coast and Geodetic Survey station of 1897 and C. I. W. stations of 1905 and 1908, 1.1 miles (1.8 km.) west-northwest of county court-house, on eastern slope of hill about 375 feet (114 meters) east of water company's reservoir; marked by marble post 8 by 8 by 48 inches (20 by 20 by 122 cm.) projecting about 24 inches (61 cm.) above surface of ground, and lettered U. S. C. & G. S. on its west vertical face, MAG. STA. on its south face, and 1897 on its east face, with a cross on the upper face marking exact point. True bearings: meteorological station on Mount Tamalpais, 26° 58′.4; flagpole on county court-house, 289° 46′.3.

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Sentinel, Colorado, 1918.—About 1 mile (1.6 km.) northeast of Sentinel Point, on backbone of ridge, 300 to 400 yards (one-third km.) southwest of a rocky summit, on grass-covered soil. Angle at station between cabin on top of same ridge about one-third mile (0.5 km.) to southwest and hill about half mile (0.8 km.) to northwest, 71°.

Shelter Island, New York, 1914.—See Derring Harbor.

Solomons, Maryland, 1919.—Two stations were occupied' designated *A* and *B*. Station *A* is near extreme southern corner of Solomons Island, on unoccupied area known as Sandy Point, about 80 feet (24 meters) nearly east of a stone marker of the United States Coast and Geodetic Survey, about 30 feet (9 meters) north of top of bank at high-water line, 278 paces southwest of nearest corner of Solomons Bank, the line to which passes nearly over second base of ball ground, and 185 paces southwest of front corner of picket fence about premises of Dr. Marsh on waterfront; marked by copper tack in top of an oak stake. True bearings: left tangent of left chimney on farmhouse across river, 57° 01′.0; light on red beacon off Point Patience, 119° 41′.6; right tangent frame house on mainland having large dormer windows, 186° 55′.9; near corner, Solomons Bank, 199° 12′.3; corner of Dr. Marsh's picket fence, 229° 56′.2; first black beacon at entrance to Solomons Landing, 234° 59′.5; Drum Point Lighthouse, 264° 18′.8; gable of white house behind Millstone Landing, 337° 27′.2; left edge of small shed across bay, nearly over spar-buoy (S6), 355° 35′.2.

Station *B* is in line with left tangent of left chimney of house across Patuxent River from Station *A*, 71.2 feet (21.70 meters) southwest of Station *A*, 23.0 feet (7.01 meters) southeast of station marker left by United States Coast and Geodetic Survey, from which a line to gable of large white barn across river to southeast passes about 1 foot (0.3 meter) west of station, about 44 feet (13 meters) from top of bank to southward, 63 feet (19 meters) from top of bank to southwest, and 24.5 feet (7.47 meters) nearly east of wooden signal-pole; marked by copper tack in top of an oak stake. True bearing: left tangent of left chimney of farmhouse across river, 57° 01′.0.

Stratton Park, Colorado, 1918.—See Broadmoor.

Trachyte Mountain, Colorado, 1918.—On eastern slope of summit, along ridge running from summit to northeast, just above an old shaft, and about 500 feet (152 meters) from triangulation signal near summit. True bearings: triangulation signal on summit, 44° 24′.2; tree on summit of Rhyolite Mountain, 100° 13′.2; railroad water-tank at Gillett, 109° 43′.0; garage on Pikes Peak, 216° 04′.8; tree on Cow Mountain, 317° 16′.7.

Washington, District of Columbia, Standardizing Magnetic Observatory, 1914–1919.—Observations were made with the standard instruments of the Department of Terrestrial Magnetism at the Standardizing Magnetic Observatory, designated S. M. O. Observations for declination and horizontal intensity were made on piers N_m and S_m, and for inclination on piers N_e and S_e. A few auxiliary observations were made on pier E_m. (See pages 199, 200, Vol. II, Researches, Department of Terrestrial Magnetism.)

Windy Point, Colorado, 1918.—About one-eighth mile (0.2 km.) south of cog-road, on backbone of salient, 25 feet (7.6 meters) west of old prospect on salient jutting down from Windy Point, 180 feet (54.9 meters) north of trench or prospect dug 2 or 3 feet (0.6 or 0.9 meter) deep across same salient; marked by mound

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Windy Point, Colorado, 1918—continued.
of stone. True bearings: stake on mountain about 1 mile (1.6 km.) north of Bull Park, 29° 35′.8; southwest corner stanchion on Pikes Peak tower handrail, 147° 41′.3; northeast corner stanchion on Pikes Peak tower handrail, 147° 48′.6; east corner of Windy Point station (stone house), 160° 06′.4; Bald Mountain signal, 316° 38′.3.

Woburn, Massachusetts, 1918.—In open lot southeast of residence of Professor G. L. Hosmer, 42.4 feet (12.92 meters) and 50.8 feet (15.48 meters) respectively from the southeast and southwest corners of the residence, 100 feet (30.5 meters) west of a wire fence parallel to Washington Street, and 111.4 feet (33.95 meters) northeast of north corner of outbuilding.

Woodland Park, Colorado, 1918.—On right of road from Manitou to Woodland Park, about one-fourth mile (0.4 km.) nearly south of railway station, 146 feet (44.5 meters) from center of road, 89.7 feet (27.34 meters) southwest of corner of fence, and 185 feet (56.39 meters) from fence corner on opposite side of highway. True bearings: cleft in mountain, 16° 45′.2; east edge of chimney on schoolhouse, 177° 22′.5; center of railroad-crossing warning, 266° 37′.2; Summit House, Pikes Peak, 357° 21′.6.

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Bahia Blanca, Buenos Aires, 1917, 1919.—The C. I. W. station of 1917, which was a practical reoccupation of the Argentine Meteorological Office station 1904, 1908, and 1913, was closely reoccupied in 1919. On land belonging to Engineer White, about 1 kilometer from town in the direction of Arroyo Maldonado, in northwest extension of street passing two squares northeast of railway station, about 300 meters northwest of nearest building in town, about 100 meters from fence corner, and 66.1 meters north of crooked wooden fence post, almost in line between fence post and municipal building in Bahia Blanca; marked by wooden peg. True bearings: chimney by elevator, 66° 52′.0; tower of municipal building in Bahia Blanca, 188° 09′.5; chimney by elevator, 329° 58′.5.

Buena Esperanza, San Luis, 1917.—Practical reoccupation of Argentine Meteorological Office station of 1913. In paddock belonging to Mr. Clark of "Tilley and Clark," about 500 meters west-southwest of railway station, in large inclosure east of machine-shed near Mr. Clark's house, about 100 meters southeast of large water reservoir, and 57.1 meters northeast of diagonal wire fence running southeast from near shed, measured at its junction with another fence running west. True bearings: pump rod on distant windmill, 9° 58′.4; center of windmill south of Mr. Clark's house, 91° 33′.4; center of top of windmill northeast of house, 111° 44′.4.

Cañada de Gomez, Santa Fe, 1917.—Practical reoccupation of Argentine Meteorological Office station of 1912. At Mr. Greenwood's estancia, east of town, 5 squares north of La Valle, 25 squares east of España Street, in paddock about 200 meters east-southeast of estancia house, 86 meters east of wire fence on west side of paddock, 58.6 meters south of north fence, and 52.8 meters from south fence. True bearings: chimney on distant house, 16° 11′.4; extreme left edge of chimney on south end of estancia house, 121° 28′.5; estancia windmill, 148° 12′.9; extreme right edge of large brick building near railway, 355° 08′.3.

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ARGENTINA—*continued.*

Chamical, La Rioja, 1917.—Practical reoccupation of Argentine Meteorological Office station of 1913. About 400 meters east of railway station, in scrub, about 300 meters northeast of railway line, north of an unfenced road crossing railway line southeast of a sheet-iron warehouse. True bearings: extreme left edge of warehouse, 57° 58′.4; ornament on south end of railway station, 80° 27′.9; mast on north end of railway-engine barn, 99° 17′.9.

Chelforo, Rio Negro, 1917.—Exact reoccupation of Argentine Meteorological Office station of 1913. About 1 kilometer southwest of railway station, on north bank of Rio Negro, near a bend in river, about 50 meters from bank and on the outer edge of and 75 meters below the beginning of a line of trees and brush on the river bank below bend; marked by a wooden post 8 by 11 cm., projecting about 20 cm. above surface, with a brass screw in top. True bearings: railway signal-post, 135° 26′.4; knob on railway water-tank, 229° 17′.1; railway signal-post, 244° 09′.9.

Chilecito, La Rioja, 1917.—Practical reoccupation of Argentine Meteorological Office station of October 27, 1913, in a paddock in northeast intersection of streets one square north of northeast corner of plaza, at a point 86.2 meters north and 30.8 meters east of mud fences along streets on south and west, and 31.8 meters west of wire fence dividing square from north to south. True bearings: cross on church, 41° 47′.7; extreme left edge of house of Tiro Federal, the right building of two on club grounds, 199° 27′.3; cross on ridge between two hills, 301° 51′.4; extreme left edge of house on street corner, 335° 21′.7.

Cipolletti, Rio Negro, 1919.—Exact reoccupation of Argentine Meteorological Office station of 1908 and 1913 and C. I. W. station of 1917. On grounds of Argentine Meteorological Office, about 1 mile (1.6 km.) northwest of railway station, in southeast corner of southwest inclosure, 31.0 meters and 29.3 meters west and north respectively of fences of close-set trees; marked by a wooden post projecting about 10 centimeters above ground, precise point being indicated by a brass screw in top of post. True bearings: base of small chimney, 39° 48′.6; base of telegraph-pole, 45° 41′.6.

Colonia Las Heras, Santa Cruz, 1919.—East of town and just east of fork of two roads branching out from end of main east-and-west street, about 100 meters east of last houses of town and about 200 meters south of railroad; marked by wooden peg about 15 inches (38 cm.) long driven flush with ground.

Comodoro Rivadavia, Chubut, 1919.—Close reoccupation of June 1913 station of Argentine Meteorological Office, about 2 kilometers north of main part of town, on hill above cemetery, about 50 meters left of winding road to oil-field measured eastward to point on sharp turn and same distance to a point northward; marked by a wooden peg. True bearings: beacon on point of nearby hill, 143° 01′.8; distant beacon on point of hill, 181° 27′.4; left corner of left stone house, 189° 33′.0; right side of steel chimney, 800 meters, 208° 14′.5.

Cordoba, Cordoba, 1917.—About 40 meters west of Argentine Meteorological Office station of 1913, about 300 meters west-southwest of Observatorio Nacional, west of Mr. Rector's quinta, in field belonging to Dr. Duschesquid, 48.5 meters from west fence, and 74.6 meters from south fence of field. True bearings: tall chimney at Hospital del Clinica, 174° 46′.8; cross on church, 198° 41′.4; extreme right edge of Mr. Zimmer's house, 266° 57′.2.

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ARGENTINA—*continued.*

Dean Funes, Cordoba, 1917.—Proximate reoccupation of Argentine Meteorological Office station of 1913. In small paddock at east intersection of Calle Carlos Pelligrini and Calle Maipu, 48.6 meters northeast of wire fence along Calle Maipu, and 47.2 meters southeast of line of fronts of three small houses on opposite side of Calle Carlos Pelligrini. True bearings: top of railway signal-post, 11° 26′.3; extreme left edge of large white building, 36° 55′.8; right edge of round water-tank, 88° 44′.6.

Dolavon, Chubut, 1919.—About 300 meters north of railroad, just left of fork in wagon road leading past cemetery, 98 paces northwest of small building, and 57.6 meters south of south corner of cemetery fence; marked by glass bottle left with neck protruding about 1 centimeter from ground. True bearings: near gable of railroad shed, 7° 21′.0; right corner of small house in valley, 14° 10′.5; middle of "M" of "C.M.C." on front of Chubut Mercantile Company store, 314° 40′.5.

Embarcacion, Salta, 1917.—Argentine Meteorological Office station of 1913 was not available because of presence of magnetic material. In paddock southeast of Embarcacion Hotel, near edge of brush, about 150 meters and 100 meters from fence to northeast and northwest respectively. True bearings: left edge of railway water-tank, 94° 16′.1; ornament on right end of railway deposit building, 157° 21′.1; left edge of top of Hotel Universal, 172° 02′.3; left edge of house, 185° 56′.0.

Florida, Buenos Aires, 1920.—Two stations were occupied. Station *A* is in vacant plot of ground 6 blocks west of Florida railway station within square bounded on north by Calle Llavallol and on west by Calle Blas Parera, 308 feet (93.9 meters) south of near side of former, and 260 feet (79.2 meters) east of far side of latter; marked by wooden peg. True bearings: minaret nearest flagstaff on residence, 8° 29′.0; spire on residence, 73° 59′.9; ventilator on distant house, 190° 41′.0; spire on church, 256° 35′.4.

Station *B* is 100 feet (30.5 meters) nearly north of *A* in line with ventilator on distant house; marked by wooden peg. True bearings: minaret nearest flagstaff, 8° 44′.4; spire on Sr. Wiggin's house, 76° 01′.7; ventilator on distant house, 190° 41′.0; spire on church, 256° 59′.1.

Frias, Santiago del Estero, 1917.—Practically a reoccupation of Argentine Meteorological Office station of 1913. In open camp, about 3½ squares east of railway station and 1½ squares south, 112.7 meters east of wooden fence along west side of Calle La Madrid, and 52.0 meters north of extension of house-line on north side of Calle Mendoza. True bearings: extreme right edge of house with blue front, 34° 17′.6; extreme left edge of white house at northwest corner of calles Mendoza and La Madrid, 76° 17′.8; left edge of distant water-tank, 136° 40′.2; cross on church, 152° 13′.3.

General La Madrid, Buenos Aires, 1917.—Close reoccupation of Argentine Meteorological Office station of 1913. Nearly south of railway station, in center of pasture east of garden belonging to Señor Robustiano de la Cuadra, 43.4 meters south of wire fence along road, and 80.1 meters east of fence of wire and cedar trees between pasture and garden.

Huahuel Niyeu, Rio Negro, 1919.—About 200 meters northwest of Hotel Argentino, on rise just outside of and overlooking town, 98 paces south of south corner of small brick building; marked by bottle buried neck down so that base is just flush with ground, base of

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ARGENTINA—*continued.*

Huahuel Niyeu, Rio Negro, 1919—continued. bottle being marked with triangle and letters CRB outside and O inside triangle. True bearings: landmark (piles of stones on horizon line, placed by Bailey Willis Commission), three-fourths mile (1.2 km.), 43° 14′.1; base of small chimney, 148° 42′.1; point on west end of building, La Maragata, 167° 23′.3; landmark, 8 miles (13 km.), 210° 10′.9; landmark, 4 miles (6 km.), 226° 47′.3; landmark, 1 mile (1.6 km.), 292° 44′.0.

Humahuaca, Jujuy, 1917.—Practically a reoccupation of Argentine Meteorological Office station of 1913. In one of a group of fields on opposite side of river from and about 400 meters northeast of railway-engine barn and water-tank, in about middle of five-sided field belonging to estate of Don Jose Zenteno, southwest of and adjoining one containing many small springs, north of field between two roads leading down to river, south of field south of adobe hut, at a point approximately in line with crooked mud fence forming south side of field containing springs, 69.6 meters from mud fence to west, and 62.2 meters from mud fence to southwest. True bearings: extreme left edge of shed over railway water-tank, 19° 12′.6; middle of left of twin domes on church, 45° 56′.4; extreme right edge of large sheet-iron building, 87° 27′.2; extreme left edge of nearby adobe house, 167° 05′.7.

Jujuy, Jujuy, 1917.—Close reoccupation of Argentine Meteorological Office station of 1913. Near southeast corner of Plaza Roca, north of house with arched front, about 100 meters west of fence along Calle General Paz, 51.0 meters north of fence along Calle Alvear, near intersection of drive entering gate at corner of Calle Alvear and Calle General Paz and another drive entering next gate to north, 11.2 meters from edge of drive to first gateway, and 14.0 meters from edge of winding drive to second gateway, and in line with edge of winding drive where it straightens to southwest. True bearings: left edge of water-tank at barracks, 112° 46′.6; left main edge of left large concrete gate-post, 200° 37′.2; left main edge of left large concrete gate-post to southeast, 299° 57′.6.

Junin, Buenos Aires, 1917.—Proximate reoccupation of Argentine Meteorological Office station of 1912. On open camp north of railway station, near northwest edge of links of Junin Golf Club, about in line with holes 3 and 4, 42.4 meters southeast of street, 50.1 meters from wire fence to southwest, and 31.8 meters northeast of hole 3. True bearings: left of three flag-poles at clubhouse, 9° 10′.7; point on right-hand one of four tanks visible over factory, 36° 45′.3; ornament on extreme right gable of gable house, 102° 27′.0.

La Madrid, Tucuman, 1917.—Practical reoccupation of Argentine Meteorological Office station of 1913. About 300 meters west of railway station, 43.7 meters west by north of a small straw hut, 26 meters east and 30 meters southeast of two small trees respectively. True bearings: top of third signal-tower north of railway station, 202° 37′.2; extreme left edge of white building with 4 chimneys, 227° 44′.9; ornament on west end of high gable on railway station, 271° 41′.9; bottom of signal-tower south of railway station, 292° 24′.3.

La Quiaca, Jujuy, 1917.—Practical reoccupation of Argentine Meteorological Office station of 1913. About 130 meters west of Hotel Central Norte, about 100 meters south of Meteorological Observatory and in line with extreme west side of kitchen of observatory, 0.8 meter south of line of north wall of hotel. True bearings: extreme right edge of observatory at eaves, 189° 50′.9; small ornament on left gable end of railway deposit building, 287° 00′.5; left knob on entrance to cemetery, 358° 51′.9.

La Rioja, La Rioja, 1917.—Practical reoccupation of Argentine Meteorological Office station *B* of 1913. In uncultivated plain east of railway station, about midway between matadero to north and new hospital buildings to south, in line with southeast side of nearest hospital building, 63.8 meters southeast of southeast corner, and 55.3 meters west-southwest of southwest corner respectively of 2 small brick ranchos. True bearings: cross on cemetery building, 7° 04′.7; edge of house, 39° 28′.6; church spire, 93° 56′.1; extreme right edge of matadero, 195° 27′.6.

Las Catitas, Mendoza, 1917.—Close reoccupation of Argentine Meteorological Office station of 1914. About 300 meters north of railway station, in peach garden belonging to Don Cesar Suarez, about 100 meters northeast of house, in unfenced roadway running north through orchard, 49.1 meters north of gate which forms entrance to orchard. True bearings: extreme left edge of Señor Suarez's house, seen over lean-to, 55° 55′.6; base of smoke-stack for canning factory, 94° 31′.0; extreme right edge of building, 343° 22′.4.

Las Flores, Buenos Aires, 1917.—About 1 kilometer north-northwest of Argentine Meteorological Office station of 1913, in pasture belonging to Señor Domingo Etcheverry, near south corner, 59.4 meters from west, and 72.2 meters from south fence, just east of blind road leading southwest from main road at a point 400 meters southeast of crossing near branching of railroad. True bearings: gable of barn near grove of trees, 17° 33′.7; left edge of adobe hut, 194° 14′.4; right of twin water-tanks of railway, 226° 29′.8; gable of white barn, 264° 24′.5.

Las Mesetas, Santa Cruz, 1919.—On estancia Las Mesetas, about 15 miles (24 km.) south of north limit of estancia, on a level plain slightly higher than site of buildings, and about 100 meters south of and almost in line with points on gables of house; marked by wooden peg about 1 foot (0.3 meter) long driven flush with ground. True bearing: point on far gable of house, 197° 51′.6.

Ledesma, Jujuy, 1917.—Close reoccupation of Argentine Meteorological Office station of 1913. In paddock belonging to Ingenio Ledesma, about 200 meters northwest of railway station, 73.1 meters, 37.2 meters, and 52.4 meters respectively from east, south, and west fences of paddock. True bearings: extreme right edge of railway-engine barn at eaves, 6° 15′.2; left edge of two-story house, 215° 15′.3; right edge of railway water-tank, 292° 03′.8; left edge of nearby building, 324° 04′.4.

Leones, Cordoba, 1917.—Practical reoccupation of Argentine Meteorological Office station of 1914. In paddock of estancia belonging to D. Benvenuto, about 1 kilometer north-northeast of railway station of Central Argentine Railway, and about 1 kilometer northwest of church, between small brick house near northeast corner of estancia and Pueblo Argentina, about 100 meters north-northwest of house, 48.2 meters west of east fence of paddock, and 63.3 meters north of south fence. True bearings: distant railway signal-post, 25° 53′.0; left edge of nearby large building, 156° 02′.8; right post of football-goal, 304° 13′.6; cross between twin towers of church, 326° 58′.8.

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Argentina—*continued.*

Mackenna, Cordoba, 1917.—Approximate reoccupation of Argentine Meteorological Office station of 1908 and 1912. About 7 blocks south of railway station, in open camp, about 400 meters south of church, 150 meters south of policia, 86.9 meters south of south wire fence of inclosure south of policia, and 12.6 meters east of extension of east side of street one block west of entrance to railway station. True bearings: extreme right spire in cemetery, 26° 00′.8; windmill at Castro Estancia, 96° 44′.3; spire of church at side of plaza, 197° 19′.2.

Mascasin, La Rioja, 1917.—Close reoccupation of Argentine Meteorological Office station of 1913. About 400 meters south of railway station, in scrub, 25 meters southwest of the farther of two prominent quebracho trees from railway station. True bearings: top of railway signal-post, 115° 09′.1; extreme left edge of railway station, 181° 34′.5; top of railway signal-post, 225° 32′.7.

Mata Grande, Santa Cruz, 1919.—In center of small inclosed field on northeast side of road, north of a clump of willow trees, about 200 meters northeast of large brick house, and 8.3 meters north of edge of small ditch; marked by wooden peg. True bearings: center of chimney of small house, 24° 57′.8; center of middle chimney of large house, 30° 04′.0; base of corner fence post, on horizon, 282° 35′.2.

Mendoza, Mendoza, 1917.—Close reoccupation of Argentine Meteorological Office station *C* of 1914. In Parque del Oeste, about 80 meters east-northeast of and in line with south end of *confiteria*, and about 200 meters west-northwest of band-stand in La Rotunda. True bearings: north edge of *confiteria*, 85° 41′.8; ornament on top of band-stand, 307° 40′.5; distant tall brick chimney, 310° 51′.8; lamp-post, 324° 53′.3.

Mercedes, Buenos Aires, 1917, 1919.—The C. I. W. station of 1917, a proximate reoccupation of Argentine Meteorological Office station of 1904 and 1912, was closely reoccupied. In quinta belonging to Señor Bernardo Rocca, formerly owned by Señor Juan F. Gnavi, about 600 meters southwest of barracks and about 200 meters west of house of Señor Rocca, 48.7 meters east of north-south fence, and 41.8 meters north of east-west fence outside a row of small trees; marked by a tent peg. True bearings: cathedral spire, 212° 41′.0; tank at barracks, 241° 27′.0; left corner of brick house, 275° 02′.8.

Navia, San Luis, 1917.—Practical reoccupation of Argentine Meteorological Office station of 1913. About 400 meters north-northeast of railway station, in middle of slightly used cross-roads cut through brush. True bearing: ornament on left end of ridge on railway station, 37° 24′.6.

Olavarria, Buenos Aires, 1917.—Practical reoccupation of Argentine Meteorological Office station of 1913. About 2.5 kilometers west of railway station, near extension of street about 5 squares south of railway station, crossing bridge in west part of town, in center of paddock belonging to Luis Spinola, 63.5 meters from south fence, 32.5 meters from west fence. True bearings: center of chimney on small brick house, 125° 12′.1; lower joint of pipe on windmill, 0.5 kilometer, 202° 47′.9; right edge of Luis Spinola's house, 245° 27′.7; left one of twin spires on cathedral, 310° 07′.1; left edge of nearby house, 337° 43′.9.

Parada Kilometro 163, Chubut, 1919.—South of Hotel Los Tigres and railroad station, on level plain, 180 paces south of railroad; marked by wooden peg. True bearing: left side of foundation of railroad water-tank, 208° 23′.0.

Patagones, Buenos Aires, 1919.—Practical reoccupation of Argentine Meteorological Office station of 1914, one-fourth kilometer northwest of town, on hill overlooking Viedma and river but concealed from Patagones, 12.5 meters south of center of branch road about 75 meters southwest of slight turn in extension of Calle Venezuela where it joins main road, 8.5 meters north of center of path following brink of hill, and 48.6 meters east of a telephone-post; marked by a wooden stake. True bearings: top of steel tower on far bank of river, 25° 19′.5; top of steel tower, 200 meters, 34° 38′.0; brick chimney, 235° 08′.1; statue on gable of theater in Viedma, 346° 27′.8.

Pergamino, Buenos Aires, 1917.—Practical reoccupation of Argentine Meteorological Office station of 1912. South of town, in estancia of Señor Villa-Nueva, west of road to "Chacra Experimental," which extends southward from Calle Rocha crossing narrow gage railway just before it branches, about in line between brick "galpon" or warehouse to northeast and house of Señor Villa-Nueva to southwest, 58.9 meters west of roadside fence and 64.1 meters north of fence along narrow lane to group of adobe huts. True bearings: extreme left edge of house of Señor Villa-Nueva, 56° 30′.6; left of twin church towers, 166° 17′.9; extreme left edge of galpon, 247° 55′.1; lone tree, 352° 33′.6.

Pichi-Mahuida, Rio Negro, 1917.—Close reoccupation of Meteorological Office station of 1913. About 400 meters south of railway station, approximately in line with cemetery and water-tank west of station, about 25 meters east of wagon trail going up hillside from river, on east bank of a narrow gully. True bearings: signal pole, 158° 16′.1; ball on top of water-tank near railway station, 181° 30′.4; signal-pole, 231° 16′.6.

Pilar, Cordoba, 1917.—On grounds of Pilar Observatory of Argentine Meteorological Office. Station *B* is an exact reoccupation of the C. I. W. station *B* of 1911, a wooden pier having been set and a small frame building erected over the spot. Declination and horizontal intensity were observed at *Pier 4*, and inclination on *Pier 5* in the new absolute observatory called station *D*. For intercomparison of instruments two stations *E* and *F* were established in line from *Pier 4* at station *D* to left edge of a house about 2 kilometers distant in azimuth 119° 20′.6. Station *E* is 71.26 meters west of northwest corner of variation observatory, 89.54 meters northeast of stone pier used as observatory azimuth mark, 73.35 meters east of east corner of observers' quarters, and 87.48 meters southwest of south corner of carpenter shop. Station *F* is 26.30 meters northwest of *E* in line toward their common azimuth mark, the left edge of house distant about 2 kilometers, whose bearing is 119° 20′.6.

Puente del Inca, Mendoza, 1917.—Practical reoccupation of Argentine Meteorological Office station of 1914. About 100 meters north of base of mountains, about 200 meters south of Hotel Puente del Inca, property of Hoteles Sud-Americanos, in line with electric-light line running northeast and 35.2 meters southwest of southwest corner of small stone building at end of line. True bearings: left edge of middle pier of railway bridge, 137° 31′.5; post next to right pier of railway bridge, 141° 36′.0; left edge of square tower on hotel, 188° 26′.9; signal-post at railway station, 244° 48′.1.

Puerto Deseado, Santa Cruz, 1919.—Practical reoccupation of Argentine Meteorological Office station of 1913. In open field just outside and northeast of town of Puerto Deseado, about 600 meters northeast of rail-

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ARGENTINA—*continued.*

Puerta Deseado, Santa Cruz, 1919—continued. road station, and about 600 meters east-northeast of a large brick chimney; marked by wooden peg about 2 feet (0.6 meter) long. True bearings: left side of elevated tank in railroad yards, 10° 20′.3; left corner of railroad station, 35° 05′.9; beacon light near mouth of Deseado River, about 1 kilometer, 37° 16′.9; electric lamp on post, 43° 09′.0; center of large brick chimney, 76° 30′.6; Penguin Islands Lighthouse, 326° 12′.6.

Puerto Madryn, Chubut, 1919.—Close reoccupation of Argentine Meteorological Office station of 1913, northwest of main part of town, on crest of small rise from shallow valley 300 meters wide and across valley from cemetery, west of house used in 1913 as meteorological station of Argentine Meteorological Office, and 145 paces northwest of and in line with small brick house and Russian-type spire of bath-house on beach; marked by a bone about 10 inches (25 cm.) long driven like a peg flush with ground. True bearings: beacon light beyond cemetery, 192° 53′.0; spire on large house, 350° 42′.2.

Recreo, Catamarca, 1917.—Practical reoccupation of Argentine Meteorological Office station of 1904 and 1913. In small open space about 300 meters west of railway station, and about 40 meters northwest of principal wandering road crossing scrub, which is continuation of second street northwest of railway station. True bearings: extreme left edge of water tank, 227° 42′.3; knob on west end of high gable on railway station, 268° 21′.7; first signal-pole south of railway station, 288° 34′.7; distant signal-pole, 311° 00′.0.

Rio Colorado, Rio Negro, 1917.—Practical reoccupation of Argentine Meteorological Office station of 1913. In middle of open camp between town and river, about 1 kilometer north of railway station, in a field belonging to Señor J. Aznarez, in line with and about 250 meters southwest of bridge leading to Pampa Central, 101.4 meters west-southwest of east fence of field, and 76.4 meters north-northwest of south fence. True bearings: knob on top of railway water-tank, 5° 54′.6; gable on Señor Burnichon's house, 143° 46′.3; gable above sign over door of Policia, Pampa Central, 224° 47′.3; southwest corner of nearby house, 277° 04′.9.

Rio Cuarto, Cordoba, 1917.—About 1 kilometer northeast of plaza, in first field north of end of Calle General La Madrid, between arroyo and river, near northwest corner of field at a point in line with fence on east side of Calle General La Madrid, 46.7 meters east of west fence and 61.6 meters south of north fence of field. True bearings: tower on college of Calle General La Madrid, 18° 25′.3; distant tall brick chimney visible over railroad bridge, 311° 48′.1; water-tank of "Agua Corrientes," 338° 49′.1.

Rio Gallegos, Santa Cruz, 1919.—Exact reoccupation of 1913 station of Argentine Meteorological Office. On beach northwest of town, about 1.5 kilometers upstream from landing place, and 16 meters north of present bank of draining-ditch; marked by large stake projecting a few inches above ground. True bearings: beacon, 500 meters, 83° 37′.4; beacon, 300 meters, 297° 58′.2; steel chimney, 2 kilometers, 317° 55′.6; cross on church spire, 1.5 kilometers, 329° 21′.2; cross on church, 1.5 kilometers, 329° 30′.8; gable of house, 300 meters, 353° 03′.8.

Rosario, Santa Fe, 1917.—Proximate reoccupation of Argentine Meteorological Office station of 1914. On Isla Espernilli, an island in front of port, almost in line with Calle San Martin, about 1 kilometer north

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ARGENTINA—*continued.*

Rosario, Santa Fe, 1919—continued. of wharves, just above ordinary high-water mark, at edge of trees and brush covering island; marked by a rough stake. True bearings: white pole beyond wharves, 20° 57′.2; red tank of "Agua Corrientes," 50° 46′.8; clock-tower of Central Argentine Railway, 63° 35′.2; spire on cathedral, 356° 28′.1.

Rosario de la Frontera, Salta, 1917.—Practical reoccupation of Argentine Meteorological Office station of 1913. One square west and 2½ squares north of northwest corner of Plaza Principal, near edge of barranca descending to river, in line with fence on north side of field north of east-west street 2 squares north of plaza, and 4.5 meters east of line of east fence of small corral to northwest. True bearings: extreme left edge of white house, 31° 19′.4; center of windmill, 267° 09′.4; center of railway signal-post, 294° 06′.2; cross on church, 353° 16′.9.

Rufino, Santa Fe, 1917.—Practical reoccupation of Argentine Meteorological Office station of 1913. On open ground belonging to Viuda di Rufino, about 700 meters west of church, about 350 meters south of rails of Buenos Aires and Pacific Railway, 79.6 meters north of wire fence on south side of extension of street two blocks south of church, 0.5 meter east of line of wire fence on east side of north-south street. True bearings: extreme right edge of house across railway tracks, 168° 43′.7; right edge of round water-tank, 235° 14′.8; church tower, 275° 02′.2.

Saavedra, Buenos Aires, 1917.—Practical reoccupation of Argentine Meteorological Office station of 1913. In quinta belonging to Martin Soubelet, 4 squares from railway station, near center of pasture west of Señor Soubelet's house, about 160 meters southwest of and directly in front of dark-brown brick building about 80 meters southeast of wire fence forming one side of pasture. True bearings: distant windmill, 28° 53′.0; signal pole, 173° 03′.4; signal-pole, 184° 01′.6; right-hand edge of dark-brown brick building, 230° 08′.3; extreme right-hand edge of Señor Soubelet's house, 257° 09′.3.

Salta, Salta, 1917.—Two stations designated *A* and *B* were occupied; both are practical reoccupations of Argentine Meteorological Office station of 1913. Station *A* is near northeast corner of leveled area used as a public meeting place on mountain slope east of city at end of Avenida Cerda, 3 meters and 4.5 meters respectively from north and west margins of area. True bearings: cross on small dome of distant church, 48° 43′.8; center of large dome at plaza, 79° 46′.5; right of twin spires on church, 101° 44′.0; prominent smoke-stack, 137° 37′.2.

Station *B* is at a spot north-northeast of leveled space, in line with station *A* and cross on small dome, east of and in line with fronts of distant houses on north side of Calle Santiago del Estero, and 18.9 meters east of extension of line of benches running along east side of leveled space. True bearings: cross on small dome on distant church, 48° 43′.8; ornament on center of large dome on church at plaza, 78° 51′.9; right of twin spires on church, 100° 37′.9; prominent smoke-stack, 136° 08′.5.

San Antonio, Rio Negro, 1919.—About 2 kilometers from Argentine Meteorological Office station of 1913, about 175 meters northwest of railroad track, about midway between two piers, at a point sometimes below water at high tide; marked by large tent peg. True bearings: northwest corner of brick building, 250 meters, 60° 31′.4; base of small chimney, 250° 08′.6.

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ARGENTINA—*continued.*

San Juan, San Juan, 1917.—Two stations, designated *A* and *B*, were occupied, both of which are practically reoccupations of Argentine Meteorological Office station *D* of 1913. Station *A* is about 300 meters north of railroad, in stony ground west of Calle Tucuman, and 40 meters south of wire fence. True bearings: chimney on adobe house, 177° 40′.7; flagstaff on highest point of Agricultural School buildings, 299° 39′.5; red and white target at railway crossing, 332° 37′.7.

Station *B* is about 150 meters east of Station *A*, on property of Agricultural School, 46 meters east of wire fence east of road, and 42 meters south of fence. True bearings: tall tree, 161° 03′.6; flagstaff on highest point of Agricultural School, 306° 59′.4; white telegraph-pole at railway crossing, 353° 16′.0.

San Julian, Santa Cruz, 1919.—About 4.5 miles (7 kilometers) northeast of main part of town, on grounds of meat-freezer of Swift and Company, in open ground between fence and shore-line, about 200 meters east of main high chimney of freezer and 24 meters south of fence; marked by peg driven flush with ground with large brass tack in top. True bearings: pillar in city of San Julian, 25° 24′.2; beacon-pole, 2 kilometers, 40° 21′.1; high chimney of freezer, 91° 20′.5; beacon-pole just visible over bank between station and shore-line, 200 meters, 277° 18′.4.

San Luis, San Luis, 1917.—Close reoccupation of Argentine Meteorological Office station *C* of 1914. About 300 meters north-northwest of old Smithsonian Observatory, in paddock situated at northeast corner of cross-roads, 54.7 meters west of eastern fence, 68.9 meters east of western fence, and 54.6 meters north of southern fence. True bearings: extreme right edge of nearby house, 36° 58′.9; extreme left edge of brick house, 157° 57′.8; extreme left edge of observatory, 347° 54′.9.

San Rafael, Mendoza, 1917.—Close reoccupation of Argentine Meteorological Office station *C* of 1914. About 4 kilometers west of railway station, in paddock belonging to Don Saul Simonovich, on continuation westward of Calle Bartolomé Mitre, near northeast corner of paddock, 108.4 meters south of north fence, 83.5 meters west of east fence. True bearings: center of windmill, 73° 02′.3; left edge of chimney on adobe house, 170° 36′.8; gutter between double gable on building, 271° 42′.5.

Santa Cruz, Santa Cruz, 1919.—Practical reoccupation of Argentine Meteorological Office station *A* of 1913. In small open field forming main plaza of town, about 300 meters southwest of church, 46.35 meters southwest of near corner of base of monument, 33 meters from fence bounding southwest, and 48 meters from fence bounding southeast side of field; marked by wooden stake. True bearings: small chimney-pipe on house, 300 meters, 165° 10′.0; cross on church, 225° 21′.0.

Santiago del Estero, Santiago del Estero, 1917.—Practical reoccupation of Argentine Meteorological Office station *B* of 1913. Northwest of city, north of hospital, in sandy plain at end of Calle Tucuman, 0.5 meter northwest of line of fronts of houses on northwest side of street to slaughter-house, and 92.4 meters southwest of south corner of house at northwest intersection of these streets; marked by brass tack in tent-stake. True bearings: extreme right edge of hospital, 16° 21′.7; tall chimney, 290° 59′.8; cathedral spire, 326° 03′.4; spire on Colegio Centenario, 343° 49′.2.

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ARGENTINA—*continued.*

Serrezuela, Cordoba, 1917.—Practical reoccupation of Argentine Meteorological Office station of 1913. About 4 squares south of railway station, on property of Dr. Moyano 73.4 meters east of fence on east side of road running from railway station and passing in front of church, at a point in line with south fence of large field on west side of road opposite house of Dr. Moyano's superintendent, northwest of a small hut. True bearings: church steeple, 183° 50′.8; house edge to left of signal-tower, 187° 54′.1; railway signal-tower, 188° 42′.3; right edge of foundation of railway water-tank, 201° 51′.9.

Talapampa, Salta, 1917.—Practical reoccupation of Argentine Meteorological Office station of 1913. In paddock about 150 meters east of Hotel del Comercio, 49.2 meters east of fence, 69.0 meters southeast of corner fence-post, and 5 meters from edge of barranca going down to the river. True bearings: extreme right corner of house across river, 9° 54′.1; cross on hillside beyond railway, 77° 34′.7; nearby signal-tower, 104° 12′.5; cross on distant small church, 239° 38′.4.

Tinogasta, Catamarca, 1917.—Practical reoccupation of Argentine Meteorological Office station *A*. In paddock belonging to Señor Simon Quintar, in northwest intersection of streets two squares north and one square east of plaza, at a point 47 meters west and 63.5 meters north of fences along streets on east and south respectively. True bearings: cross on church, visible through tree, 14° 33′.9; edge of house, 40° 00′.4; cross on large tomb at right of distant cemetery, 200° 34′.6; base of signal-tower at railway station, 277° 24′.2.

Tucuman, Tucuman, 1917.—About 50 meters northeast of Argentine Meteorological Office station of 1913, on grounds of "Escuela Agricultura Federal," about 75 meters southeast of house of superintendent, in line with right edge of second fence post east of gate in south fence and right edge of nearby white house to south, 78 meters north of fence, 42.4 meters south of southern row of big trees and 11.4 meters east of row of small trees along road. True bearings: right edge of white house, 14° 18′.5; chimney on school sugar factory, 119° 22′.5; tall chimney, 294° 18′.5; taller of two distant chimneys, 322° 44′.7.

Uspallata, Mendoza, 1917.—Close reoccupation of Argentine Meteorological Office station of 1914. In paddock about 750 meters south-southwest of railway station and 300 meters north of base of mountains, in the southwestern of the three fields forming the paddock, 48.2 meters southwest of northern fence around field, and 50.2 meters southeast of western fence. True bearings: southwest corner of brick house, 190° 49′.9; extreme left edge of water-tank, 208° 34′.2; extreme right edge of freight house, 224° 16′.6.

Valcheta, Rio Negro, 1919.—Approximate reoccupation of Argentine Meteorological Office station of 1913. About 2 kilometers northwest of railroad station, 250 meters north of police station, and 171 paces south of foot of embankment of railroad track, measured toward kilometer post 114; marked by tent peg. True bearings: right corner of house beyond railroad track, 258° 22′.5; base of signal-pole, 310° 41′.8; right corner of square water-tank, 312° 17′.6.

Valle Superior, Chubut, 1919.—See Dolavon.

Villa del Rosario, Cordoba, 1917.—Practical reoccupation of Argentine Meteorological Office station of 1913. On slightly raised open ground about 90 meters north and 60 meters east respectively of streets which intersect 2 squares north and 2 squares east of northeast

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ARGENTINA—*concluded.*

Villa del Rosario, Cordoba, 1917—continued. corner of plaza. True bearings: smoke-stack of electric-light plant, 19° 32′.6; cross on left of twin church towers, 61° 02′.8; extreme left edge of chimney on old mill, 87° 55′.9; water-tank of "Agua Corrientes," 155° 50′.1; extreme left edge of house, 200 meters, 354° 52′.9.

Villa Dolores, Cordoba, 1917.—Proximate reoccupation of the Argentine Meteorological Office station of 1908 and 1912. About 500 meters southwest of cathedral, in a paddock belonging to Don Cesaro A. Bartolome, in second field east of road to canal, about 200 meters south of its intersection with Calle Santa Fe, 62.7 meters east of west fence, 90.6 meters north of south fence, southwest and northwest respectively from two large trees in field. True bearings: extreme left edge of well-posts in nearby yard, 36° 38′.8; extreme left edge of nearest house, 143° 06′.6; cross on right tower of cathedral, 240° 59′.4.

Villa Maria, Cordoba, 1917.—Proximate reoccupation of Argentine Meteorological Office station of 1912. About 4 kilometers east-northeast of railway station, on property of Señor Rudolfo Reboyras, about 200 meters north of house of Señor Reboyras, adjoining property of Señor Rojino Rodriguez on east and property of Viuda Piazzi on west, 76.7 meters from south fence, 81.4 meters from north fence, and 86.8 meters from west fence of second field north of road. True bearings: extreme left edge of Señor Reboyras's house, 15° 18′.5; cross on dome of church at Villa Nueva, 47° 30′.1; cross on dome of church at Villa Maria, 77° 03′.3; extreme right edge of Señor Rodriguez's house, 293° 15′.7.

Villa Mercedes, San Luis, 1917.—About 200 meters north of Meteorological Office station of 1912, on Estancia Montenegro, in line with fence on right side of road running north toward estancia from opposite railway station, 61.2 meters north of south fence of estancia. True bearings: gage on red water-tank, 6° 38′.2; windmill, 94° 47′.5; windmill, 168° 55′.0; windmill pump at well-curb at estancia buildings, 287° 10′.3; knob on gray water-tank, 345° 38′.0.

Zapala, Neuquen, 1917, 1919.—The C. I. W. station of 1917, a close reoccupation of Argentine Meteorological Office station of 1913, was closely reoccupied in 1919. In corner of field south of town, 118 meters northeast of fourth post from corner in wire fence on west side of field, 96.2 meters southeast of seventh post from corner in wire fence on side of field next to town, and 68.8 meters north of small ditch running perpendicular to slope of steep hill. Line from station to railroad water-tank intersects fence about halfway between seventh and eighth post on side next to town. Marked by wooden peg. True bearings: gable of building at estancia, 35° 34′.6; point of mountain called Luan Mahuida, 90° 49′.0; point on top of water-tank near railroad, 161° 44′.1; knob on conical hill, 254° 44′.3.

BOLIVIA.

Cochabamba, Cochabamba, 1914.—In an alfalfa field inclosed by mud walls on three sides, lying east of horse-car line, and at terminus of street passing north side of Plaza 14 de Septiembre, near southeast corner of field, 59.1 feet (18.01 meters) and 72.1 feet (21.98 meters) from south and east walls respectively; marked by a tack in top of a hardwood stake. True bearing: east edge of lone house on hillside distant about 1 mile (1.6 km.), 2° 31′.5.

Copacabana, Beni, 1917.—On west bank of Beni River, in open field surrounded on three sides by houses, at a

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BOLIVIA—*continued.*

Copacabana, Beni, 1917—continued. point between steep bank of river and a wooden cross, 23 meters east of cross and 10 meters west of bank measured in same line, 48.7 meters south and 43.6 meters north respectively of two wooden crosses; marked by wooden peg.

Corocoro, La Paz, 1914.—North of railroad station, about 300 meters beyond fence on north side of railroad grounds, in a dry river-bed, 15 feet (4.6 meters) north of south bank of river

Guanay, La Paz, 1917.—At Duranplaya, about 500 meters from main part of Guanay, about 70 meters north of Tipuani River, in an inclosure surrounded by a fence made entirely of wood, 8.6 meters from north and 7.25 meters from south fence, 15.3 meters southwest of northeast corner of inclosure, 10.7 meters northwest of tree at southeast corner, 8.5 meters southwest of trunk of a tree near east fence; marked by wooden peg.

Guaporé 3, Beni, 1914.—On west bank of Guaporé River, just above a big bend estimated 14 hours paddling down-stream from mouth of Rio Verde, and 212 miles (341 kilometers) down-stream from Matto Grosso.

Guaporé 5, Beni, 1914.—On western end of sand-bar on Bolivian side of river, estimated 70 miles (113 kilometers) down-stream from Pimenteira, and about 9 miles (14 km.) down-stream from Barraca Concepcion.

Guaporé 7 (Mategua), Beni, 1914.—At village of Mategua, on south shore of Guaporé River, a few feet west of path running from river to warehouse of Stöfen, Schnack, & Müller, about 5 feet (1.52 meters) and 12.4 feet (3.78 meters) respectively from rubber trees to east and southwest; marked by tack in top of tent peg driven flush with ground.

Guayara Mirim, Beni, 1917.—Close reoccupation of C. I. W. stations of 1911 and 1914, on bank of Mamoré River, about half mile (0.8 km.) down-stream from Guayara Mirim, in path running along shore, at a point about 30 meters east of small stream, 2.7 meters north of large tree-trunk and 7.0 meters south of another large tree near river, marked by wooden peg.

Ipias, Santa Cruz, 1914.—East of stream which flows through valley at Ipias, 20 paces north of Santa Cruz–Puerto Suarez road, 55 paces northwest of intersection of north edge of road with east edge of stream, and 55 paces northwest of large lone tree which stands at south edge of road; marked by tack in peg. True bearing: prominent tree on right end of red cliff, 3 miles (5 km.), 14° 58′.2.

La Paz, La Paz, 1914, 1917.—There are two stations, designated *1912* and *1917*, respectively. Station *1912* was exactly reoccupied in 1914 and is about one-fourth mile (0.4 km.) southeast of main plaza, on first hill southeast of Plaza de Toros, in line with Calle Frias, at center of northernmost and lowest of three terraces on top of hill; marked by triangular shaped stone 3.5 by 5.5 by 12 inches (9 by 14 by 30 cm.) with cross mark at point. True bearings: cross on cathedral tower, 69° 04′.2; cathedral tower in line with Calle Frias, 116° 45′.0; highest point on Illimani, 292° 45′.7.

Station *1917* is on level pampa about 3 kilometers west of La Paz near Alto de la Paz, about 3 kilometers west of C. I. W. station of 1912, which was unavailable for reoccupation on account of landslide, about 0.5 kilometer north and slightly east of Guaqui and La Paz railroad station at Alto de La Paz, on level spot east of golf course, 35 meters east of east end of dirt bunker, and 140 paces west of railroad track;

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BOLIVIA—*continued.*

La Paz, La Paz, 1914, 1917—continued. marked by wooden peg. True bearings: right wireless tower at Viacha, 43° 32′.8; east gable of stone house, 164° 24′.8; right side of water-tank, 220° 28′.8; central high peak of Illimani, 290° 59′.6; Murillo monument, 296° 13′.9.

Mamoré 11, Beni, 1914.—On sand beach on Bolivian side of Mamoré River, in a very large bend of river, estimated 50 miles (80 km.) down-stream from mouth of Guaporé River.

Mategua, Beni, 1914.—See Guaporé 7.

Motacusito, Santa Cruz, 1914.—East of village, near foot of escarpment, 40 feet (12.2 meters) southwest of south one of two springs which supply village with water, 15 feet (4.6 meters), 12.3 feet (3.7 meters), and 17 feet (5.2 meters) respectively from three conspicuous trees to east, southeast, and northwest; marked by a tack in top of stake.

Muque, Beni, 1917.—On right side of Beni River, about 600 meters west of mouth of brooklet Muque, on beach at point where river makes turn from southwest to north, about 20 meters from present river bed; marked by three tripod pegs 3 feet (0.9 meter) long, driven flush with ground.

Oruro, Oruro, 1914.—Practical reoccupation of C. I. W station of 1912. About 1 mile (1.6 km.) south of town, 67 paces northwest of northwest corner of rifle-club inclosure, 92 paces west of railroad, 71.3 feet (21.73 meters) east of cemetery wall, and 109.7 feet (33.44 meters) from its southeast corner; marked by a tack in top of stake. True bearings: tip of ornament on dome in cemetery, 98° 21′.0; weather vane on cupola in Oruro, 174° 14′.4.

Puquina, Santa Cruz, 1914.—About one-fourth mile (0.4 km.) northwest of town, on east bank of river, about 300 meters up-stream from ford where road to Santa Cruz crosses river, opposite a mud bake-oven belonging to house among trees on west bank, 24 paces from river, 21 paces north of lone tree in bushes, and 48 paces from a gate into a cultivated field to northeast; marked by tack in top of stake driven flush with ground. True bearing: cross on church tower in town, 328° 52′.8.

Riberalta, Beni, 1917.—On east bank of Beni River, about 300 meters west of plaza, in open triangular field on high bank of river, 18 meters east of brink of bank, 32 meters west of post in front of small house; marked by stake. True bearings: left wireless mast of radio-station, 800 meters, 21° 40′.2; right wireless mast, 26° 35′.9.

Rio Grande, Santa Cruz, 1914.—On east bank of Rio Grande, about 50 yards (46 meters) east of point on bank just south of crossing of main trail to Puerto Suarez over river, at a point between two other trails which merge into one just south of junction with main trail about 50 yards (46 meters) from river bank, 25 paces south of junction of two branch trails, and 1 pace from each; marked by peg projecting about 3 inches (8 cm.) from ground.

Rurrenabaque, Beni, 1917.—On east bank of Beni River, 300 meters north slightly west of plaza, on level grass-covered patch just above beach, 5 meters east of high-water mark, 16.4 meters northeast of frame for seasoning wood, 4 meters north of north end of short ditch; marked by tent-peg. True bearings: south corner of house across river, 78° 06′.6; north corner base of cross 97° 04′.8.

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BOLIVIA—*continued.*

Samaipata, Santa Cruz, 1914.—Northwest of town, in center of a circular grass plot in a gully about 150 yards northwest of point one square and 112 paces north of plaza where gully cuts road which bounds plaza on west; marked by tack in top of stake driven flush with ground and covered with triangular stone 6 inches (15 cm.) thick and 12 inches (30 cm.) on a side with cross cut in top. True bearing: east edge of base of unfinished church tower in square north of plaza, 319° 24′.4.

San José, Santa Cruz, 1914.—In southeast corner of block east of plaza, north of road, Santa Cruz to Puerto Suarez, southeast of old Jesuit temple, 23.7 feet (7.22 meters) northwest of 4-foot (122 cm.) post that marks corner of block, and 54.6 feet (16.64 meters) southwest of a tree which stands east of road bounding block on east; marked by tack in top of stake. True bearings: left end of top of front wall of temple, distant about 100 meters, 84° 57′.0; spire at west end of cloister, 94° 36′.6; center of top of bell-tower, 113° 02′.2; cross on church, 125° 45′.2.

San Luis, Beni, 1917.—On left side of Beni River, about 8 kilometers below junction of Madidi and Beni rivers, about 3 kilometers west of Cavinas, a Catholic Mission and important rubber barraca, at a point 50 meters from river, 44.0 meters northeast of north corner of largest house in San Luis, 29.9 meters east of near corner of fence, and 12.5 meters north of north corner of small corral; marked by wooden peg.

Santa Cruz, Santa Cruz, 1914.—East of town, on grass plot along west front of town cemetery, 92.2 feet (28.10 meters) west of front wall of cemetery, 53.2 feet (16.21 meters) east of pasture fence, and 70.5 feet (21.49 meters) north of nearer gate-post of gate at southeast corner of pasture; marked by tack in top of stake driven flush with ground. True bearing: tip of cathedral tower on main plaza, 76° 38′.6.

Santiago, Santa Cruz, 1914.—About 250 paces east of village plaza, between main path leading eastward and river bank, about 11 paces south of path, and 22 paces north of river bank, in a path which leads toward river; marked by tack in top of stake, and witnessed by letters C.I.W. cut in south face of fence post near main path northwest of station. True bearings: sharp point on rock on crown of hill, 199° 06′.2; lone rock spire on left end of rock palisades, 227° 06′.0.

Sorata, La Paz, 1917.—About 200 meters southwest of main plaza, in yard of Mr. G. W. Snyder, 7.8 meters north of south wall, 20.4 meters from southeast corner of wall, 7.5 meters north and 16.3 meters west of large eucalyptus trees near south and east walls respectively; marked by brass tack in top of peg. True bearings: near corner of wall, 91° 26′; north corner of small house across valley, 91° 52′.7; point above cliff, 350° 12′.1.

Tarene, Beni, 1917.—On east bank of Beni River, about midway between Indian settlement, "Remanso de Taqueral," and San Marcos and about 20 kilometers from each, about 500 meters down stream from junction of Beni and Tarene rivers, on beach on point where Beni River makes turn from northwest to northeast, about 60 meters from low-water mark of river.

Totora, Cochabamba, 1914.—About one-fourth mile (0.4 km.) nearly north of town, just east of road leading to Santa Cruz, on level ground east of an Indian brick factory consisting of five dilapidated ovens, 103.7 feet (31.61 meters) north-northeast of north-

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BOLIVIA—*concluded.*

Totora, Cochabamba, 1914—continued.
east corner of southeast oven, 68.6 feet (20.91 meters) southeast of northeast oven; marked by tack in top of stake driven flush with ground. True bearing: center of window of chapel on hillside, 1 mile (1.6 km.), 105° 28′.8.

Tres Cruces, Santa Cruz, 1914.—On north side of road from Santa Cruz to Puerto Suarez, 7 paces north of center of road, 7 paces south of pasture fence, 31 paces southwest of east corner of pasture, and 61 paces southwest of southeast corner of corral belonging to small fort of Tres Cruces; marked by a tack in top of a stake driven flush with ground.

Tucabaca, Santa Cruz, 1914.—On south bank of Tucabaca River, east of Santa Cruz–Puerto Suarez road and south of a line of trees along bank, 63.4 feet (19.3 meters) south of east tree of row, 76 feet (23.2 meters) southeast of a big dead tree in row, and 53 feet (16.2 meters) northeast of lone tree standing on west side of road, south of row of trees; marked by a tack in top of stake.

Uyuni, Potosi, 1917.—Proximate reoccupation of C. I. W. station of 1912. About 0.5 kilometer northwest of plaza, in acute angle formed by intersection of two roads, 24 feet (7.3 meters) southwest of road running northwest, and 56 feet (17.1 meters) north of road running west; marked by wooden peg. True bearings: southwest corner of distant white wall, 9° 28′.0; point of distant mountain between two less-pointed ones, 154° 44′.1; near corner of nearby mud-hut, 271° 02′.1; south side of chimney at railroad shops, 295° 52′.0.

Vacas, Cochabamba, 1914.—South of lower road entering Vacas from Cochabamba, in center of a circular depression in angle formed by walls of two inclosures, west and south respectively, of house of Miguel Castro, in line with south wall of south inclosure, 34.4 feet (10.48 meters) west of southwest corner, and 69.0 feet (21.03 meters) south of south wall of west inclosure; marked by tack in stake. True bearings: tip on church tower, 219° 53′.4; east edge of cemetery wall, half mile (0.8 km.), 348° 14′.0.

Yacuses, Santa Cruz, 1914.—In a clearing on Santa Cruz–Puerto Suarez road, between water-hole or lagoon and large wire-fenced inclosure, about 100 meters southwest of house, 131.5 feet (40.08 meters) south of wire fence, 60.9 feet (18.56 meters) west of nearest of 3 posts in line remaining from an old house that stood in clearing, and 6.9 feet (2.10 meters) north of extension of line of posts; marked by tack in top of peg.

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Abuna, Matta Grosso, 1917.—Practical reoccupation of C. I. W. station of 1911, on north bank of Madeira River, between railroad track and river, 71 paces southwest of monument erected by engineers of the Madeira–Mamoré Railway, 12.9 meters west of wire fence, 19.8 meters east of another wire fence, and 7.5 meters north of brink of bank of river; marked by stake driven flush with ground. True bearings: south gable of hotel roof, 188° 20′.3; near corner of Café Brazil, 290° 27′.8.

Alcobaça, Para, 1915.—On railroad property, west of Tocantins River, about 100 yards (91 meters) west of railroad superintendent's house, 34.3 feet (10.45 meters) northwest of fence inclosing cultivated ground; marked by tall 3-inch (8-cm.) hardwood stake. True bearings: stump 80 feet (24.4 meters) high in cultivated field, 17° 14′; large lone sumahuma

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BRAZIL—*continued.*

Alcobaça, Para, 1915—continued.
tree, 214° 58′.6; left edge of railroad superintendent's house, 251° 47′.2; left edge of house of José Monteira, 293° 54′.8.

Allianca, Amazonas, 1917.—On right bank of Purus River, about 3 kilometers southwest of Canotama, about 200 meters northeast of largest house of Allianca, about 10 meters from river, on ground which is overflowed in high water every year, and 5 meters northwest of small pond; marked by peg about 1 meter in length, projecting 2 centimeters above ground. True bearings: west gable of largest house, 31° 22′.0; right corner of small white house, about 400 meters, 44° 57′.0; north gable of small tile-roofed house, about 100 meters, 342° 16′.3.

Almeirim, Para, 1918.—On left bank of Amazon River, in opening on top of very high bank between church and jail, 39.4 meters southeast of southeast corner of small room attached to church, 47 meters northwest of north corner of jail and 39.6 meters northeast of west cement post at top of cement incline to river; marked by wooden peg. True bearing: point on west cement post at gate, 319° 25′.9.

Amarração, Piauhy, 1919.—In open lowlands, about 200 meters east of church, 120 meters back from beach on prolongation of line of houses on south side of Rua Joaquim Pires, and 58 meters southwest of vacant thatched house; marked by a large wooden stake driven flush with sand. True bearings: east corner of railway depot, 56° 50′.2; eastern spire on church, 82° 09′.9; western corner of church, 86° 42′.8; light- and signal-tower, 248° 23′.6; western corner of highest house to south, 338° 17′.9.

Araguary, Minas Geraes, 1915.—In Observatory Square, 105 feet (32.0 meters) northeast of southeast corner post of observatory inclosure; marked by peg driven flush with ground. True bearings: left edge of Diniz Santos smoke-stack, 59°10′.2; foot of weather-vane pole in observatory inclosure, 49° 29′.6; right edge of house on corner of square, 226° 45′.4; large tree in corner of square, 331° 42′.4.

Araguaya River 11, Matto Grosso, 1915.—On west bank of Araguaya River, about 75 yards (69 meters) from water's edge, and about midway between Valadores Island and Colombo Island; marked by peg driven flush with ground.

Aruma, Amazonas, 1917.—On right bank of Purus River, 212 miles (341 km.) by river from Manaos, on ground which is overflowed at height of wet season, at a point about 40 meters west of thatched house, about 3 meters southeast of path leading from river to house, and 5.0 meters north, 14.9 meters west and 17.9 meters southwest of three trees respectively; marked by wooden peg.

Asareas, Matto Grosso, 1914.—At a settlement known as Asareas, on trail between Sao Luiz de Caceres and Matto Grosso, 4 paces south of new road, 23 paces north of telegraph-line, 4.9 feet (1.49 meters) north of post 3 inches (8 cm.) in diameter projecting 3 feet (91 cm.) above ground, and 10 paces north of old road measured from point on road 67 paces west of wooden bridge over small stream; marked by tack in top of tent peg driven flush with ground.

Barra do São Manoel, Amazonas, 1918.—On left bank of Tapajos River, near junction of Tapajos, Sao Manoel, and Juruena rivers and about 1 kilometer from point, in middle of river, where states of Para, Amazonas, and Matto Grosso meet, about 150 meters south of buildings, on high ridge about 15 meters west of top

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BRAZIL—*continued.*

Barra do São Manoel, Amazonas, 1918—continued. of slope and 2 meters south of path; marked by wooden peg. True bearings: right corner of house on Espirito Santo Island, 158° 47′.6; right corner of house across Tapajos River, 209° 19′.5.

Barreira Branca, Goyaz, 1915.—Near south end of a low-water island in Araguaya River above Leopoldina, and in general vicinity known as Barreira Branca (white walls) on account of white clay bluffs of river.

Barreira Canta Gallo, Matto Grosso, 1915.—Near center of small low-water island near west bank of Araguaya River.

Barreira do Padre, Matto Grosso, 1915.—On temporary beach of west bank of Araguaya River.

Barreira Quicaca, Gayaz, 1915.—On sand spit east of bluff banks known as Barreira Quicaca, on Araguaya River.

Bella Vista, Goyaz, 1915.—Near center of town square, 183.6 feet (55.96 meters) southwest of middle of door of church Senhora da Piedade, 231.1 feet (70.44 meters) northeast of northwest corner of house of Vincente Bonifacio; marked by cross scratched in top of 6-inch (15-cm.) stone buried flush with ground. True bearings: right edge of house of Vincente Bonifacio, 40° 54′.7; right edge of church Senhora da Piedade, 225° 57′.6; right edge of post-office, 353° 58′.4.

Boca de Capana, Amazonas, 1914.—On west bank of Madeira River, at mouth of Capana River, 15 paces east of a path, and approximately 75 yards south of main living house; marked by tack in top of tent peg driven flush with ground.

Bocca do Acre, Amazonas, 1918.—On right bank of Purus River, west of town, about 1 kilometer west of mouth of Acre River, and south of station of Peruvian Boundary Commission; marked by peg. True bearing: right corner of house across Purus River, 192° 41′.2.

Bocca do Foro Island, Goyaz, 1915.—On west shore of Bocca do Foro Island; marked by peg driven flush with ground.

Bocca do Pauhiny, Amazonas, 1917.—On left bank of Purus River, about 300 meters below mouth of Pauhiny River, about 50 meters east of a house and about 5 meters west of top of river bank; marked by a stake projecting about 20 centimeters above ground. True bearings: east gable of house across Pauhiny River, 35° 07′.6; north corner of nearby house, 50 meters, 107° 47′.2; west corner of house across Purus River, 337° 55′.2.

Bocca do Purus, Amazonas, 1917.—About one-fourth mile (0.4 km.) north of mouth of Purus River, on right bank of Solimoes River, about 75 meters northeast of house of Manoel Martins, 15 paces east of river bank, 50 paces north of large tree, 31.5 meters northwest and 21.0 meters southwest of two other trees respectively; marked by a bottle buried with neck projecting about 4 centimeters above ground. True bearing: left corner of house across river, about 3 kilometers, 115° 03′.1.

Bom Futuro, Amazonas, 1914.—At barraca of Bom Futuro, on Madeira River, on open ground between line of houses and bank of river, 79.5 feet (24.23 meters) west of bell-tower standing between owner's house and church, 21 feet (6.4 meters) southeast of flag- and light-pole, 20 paces and 23 paces respectively south and north-northwest from large trees; marked by tack in top of tent peg driven flush with ground. True bearing: right window of house across river, half mile (0.8 km), 133° 37′.8.

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BRAZIL—*continued.*

Bragança, Para, 1918.—About 200 meters north of railroad station, in open space west of street leading north from station, 19.6 meters north of northeast corner of small mud house, 30.3 meters west, 29.3 meters southwest respectively of northwest corners of two buildings east of street, 8 meters southeast of path, and 19.3 meters southeast of tree; marked by wooden peg. True bearing: left side of top of doorway of mud house, about 200 meters, 173° 48′.0.

Cabedello, Parahyba, 1919.—On beach east of old fort, halfway between high-tide line and bushes along beach, and 60 meters east of north bay of fort; marked by wooden stake driven below sand. True bearings: east corner of north bay of fort, 51° 47′ 8; east corner of church across harbor, 110° 45′.0; tip of lighthouse, 235° 06′.5; west spire of Cabedello church, 335° 21′.2; east corner of round tower of fort, 344° 43′.2.

Café Island, Goyaz, 1915.—Near center of southeast shore of Café Island in Araguaya River, about 30 feet (9 meters) northwest of water's edge.

Cafetal Matto Grosso, 1914.—See Guaporé 6.

Cameta, Para, 1915.—On west side of Tocantins River, 80.9 feet (24.66 meters) east of church, Our Lady of Mercies, measured from foot of wall directly under first low window near southeast corner, 58.3 feet (17.77 meters) southwest of west corner of private residence fronting on São João Baptista Street, 51.9 feet (15.82 meters) east of lamp-post about 240 feet (73.2 meters) north of northeast corner of large house belonging to Horatio de Linas, and about 200 feet (61 meters) west-northwest from corner of retaining wall at river. True bearings: left edge of house of Horatio de Linas, 26° 49′.7; left uppermost edge of church, Our Lady of Mercies, 103° 23′.7; foot of large wooden cross in square, Largo do Merces, 153° 59′.7; left edge of house fronting on São João Baptista Street, 203° 23′.5; upright in hut across river, 6 kilometers, 302° 22′.3.

Camocim, Ceara, 1919.—Northwest of Matriz church, in Matriz Praça, 62.2 meters northwest of base of cement cross in front of church, 44.6 meters southwest of 6-inch iron pipe planted upright in ground, 30.8 meters northeast of row of houses measured from line dividing red from yellow houses on west side of praça, and 19.9 meters north-northeast of large tree; marked by a stone 10 by 10 by 40 centimeters, sunk 8 centimeters beneath surface of sandy soil. True bearings: southwest corner of house at northwest corner of praça, 154° 24′.4; west corner of house at northeast corner of praça, 192° 47′.0; south corner of railway depot, 267° 42′.4; north side of chimney at upper edge of third section from top, 307° 52′.0; cross on church spire, 313° 23′.8; northwest corner of house at southwest corner of praça, 342° 57′.4.

Campinas, Goyaz, 1915.—Near center of church square, 83.4 feet (25.42 meters) west of base of large wooden cross, 211.9 feet (64.59 meters) southwest of southeast corner of house belonging to José Rodriguez de Moraes on north side of square, 214.5 feet (65.38 meters) northeast of northwest corner of house belonging to Jose Rodriguez de Moraes on southwest corner of square. True bearings: right edge of de Moraes house on south side of square, 48° 58′.3; right edge of de Moraes house on north side of square, 207° 20′.8; right edge of church, 291° 51′.1.

Canga Island, Goyaz, 1915.—On temporary sand spit near center of east side of Canga Island in Araguaya River.

Castanhal, Para, 1918.—In southwest part of town, about 300 meters south of schoolhouse, in T-shaped open

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BRAZIL—*continued.*

Castanhal, Para, 1918—continued.
space near row of small rubber trees, about 10 meters south, slightly west, of west tree; marked by peg.

Catalão, Goyaz, 1915.—About half kilometer southeast of railroad station, and 62.3 feet (18.99 meters) west of southeast corner of observatory inclosure; marked by cross scratched in top of rough stone buried flush with ground. True bearings: center cross of three prominent crosses on hill, 35° 31′.2; gable of railroad station, 140° 21′.7; chapel of St. John on hill, 4 kilometers, 184° 46′.1; weather-vane pole in observatory inclosure, 253° 45′.1.

Conceicão, Para, 1915.—In north corner of Largo Frei Gil, 74.3 feet (22.65 meters) southeast of middle of door-sill of bishop's house, 75.9 feet (23.13 meters) west of large lone tree in square, 166.6 feet (50.78 meters) northwest of foot of large wooden cross in square, and about 75 feet (23 meters) northeast of band-stand; marked by cross scratched in top of natural stone about 8 inches (20 cm.) square buried flush with ground. True bearings: left edge of church under construction, 41° 07′.7; small spire on west corner of house of Sampulicio Pereira da Costa, 179° 43′.9; right edge of church at eaves, 225° 33′.7; foot of large wooden cross, 298° 37′.5.

Curralinho, Goyaz, 1915.—In Santa Vares Square, 80.3 feet (24.48 meters) east of corner of cemetery wall, and in range with corner of cemetery wall and a tree cross in cemetery; marked by cross scratched in top of natural stone buried flush with ground. True bearings: cross on chapel in cemetery, 53° 20′.7; tree cross in cemetery, 82° 51′.9; right edge of farmhouse, 1 kilometer, 123° 14′.6.

Corumba, Matto Grosso, 1914.—Exact reoccupation of C. I. W. station *A* of 1913, on north bank of Paraguay River, about 250 meters west of a sunken iron barge, on land submerged at very high water, about 25 meters north of bank, 69.3 feet (21.1 meters) south of a tree stump standing near a water-hole and a pile of stones, and to which a launch is moored by an iron cable which passes at a distance of 38.0 feet (11.6 meters); marked by peg, and witnessed by a large stone planted 4.5 feet (1.4 meters) to south, projecting 1.5 feet (0.46 meter) above surface. True bearings: right edge of black smoke-stack on brewery, 37° 55′.0; tower on Brazil-Bolivia boundary, 290° 06′.6; church spire, 311° 11′.3; point over center door of electric-light plant, 356° 30′.9.

Empreza Acre, 1918.—On left bank of Acre River, 84.2 meters northeast of nearest corner of triangular tower for telephone-wires, 59.4 meters southeast of east corner of small stucco building, 2 meters from top of high bank. True bearings: right side of right door in "Casa Fecury," 5° 03′.6; point over gable of Hotel Madrid, 18° 29′.6; top of wireless mast, 119° 21′.3; left corner of square tower for telephone-wires, across river, 351° 03′.3.

Espinhel, Para, 1915.—At point known as Espinhel, on left bank of Araguaya River, about 3 kilometers above Sapucaia Island, 20 feet (6.1 meters) south of water's edge, and 50 feet (15.2 meters) north of forest line; marked by stake driven flush with ground.

Fazenda Cachoeira, Goyaz, 1915.—Near town of Ipamiri, in pasture north of farmhouse and cattle yards, 42 feet (12.8 meters) northeast of southwest corner of pasture fence, 11.7 feet (3.57 meters) east of high fence, and 168.6 feet (51.39 meters) south of large tree on far side of creek; marked by cross scratched on top of rock buried flush with ground. True bearings: trunk of large tree, 182° 17′; left edge of railroad switch-house, 221° 28′.4; right edge of farmhouse, 316° 18′.2.

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BRAZIL—*continued.*

Fontura's Village, Matto Grosso, 1915.—On sand spit on south side of river branch, opposite Caraja Chief Fontura's village.

Fortaleza, Ceara, 1919.—About 1 mile (1.6 km.) east of Cathedral Plaza, near beach, in a field bounded on east side by an open road meeting beach at right angles being second road from beach after leaving customs pier, at a point exactly in line with west seminary (Praiana) spire and north cathedral spire, about 60 meters southeast of palm house of Francisco Marcellino, 42 meters south of wire fence near top of beach bank measured from a point 12 meters east of northwest corner of field, 57 meters west of fence along road at east side of field, and 14.2 meters east of fence between two fields; marked by a tent stake driven about 10 centimeters below surface of sand. True bearings: north gable of palm house near center of field, 100 meters, 41° 31′.6; east seminary spire, 900 meters, 79° 17′.2; west seminary spire in line with north cathedral spire, 79° 24′.1; flagpole on schoolhouse in fishing hamlet about 500 meters east of custom-house, 900 meters, 107° 25′.1; east corner of house of Francisco Marcellino, 133° 13′; east corner of iron triangulation tower, 100 meters, 321° 45′.6.

Fumasa, Matto Grosso, 1914.—On Fumasa hacienda, on trail between Sao Luiz de Caceres and Matto Grosso, west of a short arm of Rio Jabura, in pasture south of owner's house, 52 paces east of corral, 26 paces north of fence, and 34 paces south of an exceptionally large tree; marked by tack in top of tent peg projecting 2 inches (5 cm.) above ground. True bearing: southwest corner of whitewashed house, 150 yards (137 meters), 140° 13′.7.

Goyaz, Goyaz, 1915.—In Fountain Square, 103.3 feet (31.49 meters) southwest of north corner of public fountain, 277.3 feet (84.52 meters) northwest of northwest corner of police station, 162.9 feet (49.65 meters) south of middle of door of Portuguese consulate; marked by peg driven flush with ground. True bearings: left edge of drinking fountain, 25° 47′.4; cross on chapel of Santa Barbara on hill, 1 kilometer, 149° 37′.6; left edge of police station, 343° 38′.0.

Grande Rapids, Para, 1915.—Near lower end of rapids, called Cachoeira Grande, about 200 feet (61 meters) southwest of Carajasimbo Rapids, middle one of three channels by which river descends, a few feet southwest of portage path, 33 feet (10.1 meters) northeast of far edge of nearer of two large rocks, 44.4 feet (13.53 meters) northeast of far edge of farther rock, and about 2 feet (61 cm.) northwest of point in range with middle of two rocks.

Guajaratuba, Amazonas, 1917.—About 50 meters north west of main house of Guajaratuba, about 4 meters east of bank of Purus River; marked by peg projecting about 15 centimeters above ground.

Guaporé 1, Matto Grosso, 1914.—On west bank of Guaporé River, estimated 65 miles (105 km.) down-stream from Matto Grosso; marked by tent-peg driven flush with ground.

Guaporé 2, Matto Grosso, 1914.—On small grass-covered sandy point on west bank of river, at mouth of small tributary, estimated 18 miles (29 km.) down-stream from plantation known as Tacuari, and 140 miles (225 km.) down-stream from Matto Grosso.

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BRAZIL—*continued.*

Guaporé 4, Matto Grosso, 1914.—On sand beach of up-stream end of larger of two islands in Guaporé River, about one hour's paddling up-stream from warehouse of Stöfen, Schnack, & Muller Company, known as Pimenteira.

Guaporé 6, Matto Grosso, 1914.—On sand beach on east end of large island, estimated 21 miles (34 km.) down-stream from Cafetal.

Guaporé 8, Matto Grosso, 1914.—On sand beach on east bank of Guaporé River, estimated 12 miles (17 km.) upstream from Santa Rosa, and 180 miles (290 km.) down-stream from Mategua.

Guaporé 9, Matto Grosso, 1914.—On sand beach on up-stream end of first island below rapids of Forte do Principe do Beira, estimated 3 miles (5 km.) below Barraca Concepcion and the foot of the rapids.

Guaporé 10, Matto Grosso, 1914.—On beach on northeast side of small low-water island in Guaporé River, about 200 yards (183 meters) long by 30 yards (27 meters) wide, and estimated 36 miles (58 km.) down-stream from rapids of Forte do Principe do Beira.

Humayta, Amazonas, 1914.—On open ground between town of Humayta and bank of Madeira River, in line with center of Rua Fonseca Continho, 11 feet (3.4 meters) west of top of river bank, and 95.5 feet (29.11 meters) east of large palm tree standing in center of intersection of Rua Fonseca Continho and Rua Monteiro; marked by track in top of post 3 inches (8 cm.) by 4 inches (10 cm.) and 3 feet (91 cm.) long, projecting 1½ feet (46 cm.) out of ground with C. I. W. 1914 on top. True bearings: cross on church tower, 200 yards (183 meters), 143° 25′.4; right edge of east wall of forum, one-fourth mile (0.4 km.), 155° 17′.9; east tip on pavilion, 50 yards (46 meters), 346° 16′.9.

Hyutanahan, Amazonas, 1917.—On left bank of Purus River, northeast of buildings of Hyutanahan, on high ground 160 paces along path from north house, 7 meters southeast of path northwest of three large Brazil-nut trees, and about 20 meters south of palm tree; marked by a stake about 1 meter in length projecting 2 centimeters above ground. True bearing: north gable of north house, 58° 30′.3.

Iguatu, Ceara, 1919.—About half kilometer south of railway depot, in a cultivated field 26 meters southeast of road running past new cemetery, about 180 meters south of cemetery, 27.35 meters east of fence-corner at edge of road, and 28.6 meters southeast of fence along road measured in a line toward south corner of house across road; marked by a round wooden stake driven below surface of sand. True bearings: cross on west wall of cemetery, 167° 27′.4; cross over cemetery entrance, 200 meters, 186° 03′.3; cross on church spire, 900 meters, 196° 36′.2; flagpole on railway depot, 206° 14′.6; pointed hill to eastward, 13 kilometers, 276° 25′.

Incante, Amazonas, 1914.—At barraca Incante, on north bank of Madeira River, 42.2 feet (12.86 meters) and 48.7 feet (14.84 meters) respectively from southwest and southeast corners of living house; marked by tack in top of tent peg driven flush with ground.

Itaboca, Para, 1915.—Opposite Grande Cachoeira of Itaboca series of rapids, 203.3 feet (61.97 meters) east of middle of door of house of Antonio José Araujo, 168.4 feet (51.33 meters) northeast of large tamarind tree, about 200 feet (61 meters) southeast of large lone sumahuma tree, about 250 feet (76 meters) south of similar lone sumahuma tree, and about 20 feet (6 meters) west of high-water mark;

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BRAZIL—*continued.*

Itaboca, Para, 1915—continued.
marked by peg driven flush with ground. True bearings: tamarind tree, 47° 11′.1; middle of door of house of Antonio José Araujo, 96° 45′.5.

Jacusão Rapids, Para, 1915.—On flat space on large rock among the riffles, exposed in dry season, about 100 yards (91 meters) from west bank of Araguaya River, 27.5 feet (8.38 meters) northwest of larger and nearer of 2 loose boulders, and 18.5 feet (5.64 meters) southwest from center of large rift in rock; marked by cairn of rock.

Labrea, Amazonas, 1917.—About 400 meters southeast of plaza and church in large open space east of town in line with wireless mast and south gable of tile-roofed house. True bearings: wireless mast 101° 12′.6; cross on church steeple, 129° 45′.8.

Lago Barreira do Viado, Goyaz, 1915.—On sand spit on west side of Bananal Island; marked by peg driven flush with ground.

Lake Gaiba, Matto Grosso, 1914.—On right bank of Paraguay River, below Lake Gaiba, near a number of old deserted sheds and ruins of an old large wooden house, beside path running northeast from landing, about 75 yards (69 meters) northeast of nearest shed, and about 5 paces from edge of river; marked by a tack in top of a wooden block 8 by 24 by 24 inches (20 by 61 by 61 cm.), projecting 1 foot (0.3 meter) above ground.

Leopoldina, Goyaz, 1915.—On church property east of Araguaya River, 31 feet (9.5 meters) from nearest point of bluff bank of river, 276.6 feet (84.31 meters) northwest of middle of doorsill of San José Church, 110.4 feet (33.65 meters) northeast of northwest corner of house of Maxeina Corvalho; marked by cross scratched in top of natural stone. True bearings: right edge of house of Maxeina Corvalho, 16° 13′.2; trunk of lone tree in lot, 240° 47′.6; left edge of house of Severina Maria Concessao, 295° 07′.4.

Manaos, Amazonas, 1914, 1917, 1918.—Two stations designated *I* and *II*, were occupied. Station *I*, occupied in 1917 and 1918, is about 150 meters southwest of station of Brazilian Commission of 1903 and C. I. W. station *I* of 1910, and about 75 meters southwest of C. I. W. station *I* of 1914. About three-fourths mile (1.2 km.) southeast of main business district of Manaos, at foot of avenida, near top of hill, on east side of small stream about 100 meters southwest of house marked "Villa Cavalcante 1912," 31.4 meters northwest of south lamp-post, 21.2 meters west of next lamp-post; marked by wooden peg driven flush with ground. True bearings: square church tower, 130° 05′.0; opera-house dome, 1 mile (1.6 kilometers), 152° 23′.3; west side of reservoir, 4 kilometers, 179° 54′.6.

Station *II* is exact reoccupation of C. I. W. station *II* of 1913, in vacant square south of Instituto Benjamin, west of garden wall on east side of street. This station is affected by proximity of electric-car lines.

Maraba, Para, 1915.—Northwest of town of Maraba, about in line with southwest side of street Fifteenth of November, 86 feet (26.2 meters) northwest of passage cut into bluff at foot of street, 30 feet (9.1 meters) from edge of steep descent to low water, and 204.7 feet (62.39 meters) from largest tree in clump to northeast. True bearings: gable of house of Sergio Prado, 100 yards (91 meters), 38° 00′.3; point of Quandangu Island, 91° 37′; tree beyond a house on opposite side of river, 3 kilometers, 161° 56′.6; largest tree of small clump, 238° 32′.

SOUTH AMERICA.

BRAZIL—*continued.*

Matto Grosso, Matto Grosso, 1914.—At port of Matto Grosso, on east bank of Guaporé River, 39.5 feet (12.04 meters) west of brown-stone wall in front of old Jesuit church, later used as a military cuartel; in range with south side of narrow portion of old church; marked by tack in top of tent peg driven flush with ground. True bearing: right edge of old town church, one-fourth mile (0.4 km.), 263° 07'.5.

Melancia Island, Goyaz, 1915.—On sand spit near center of east shore of Melancia Island, about 30 yards (27 meters) west of water's edge; marked by peg driven flush with ground.

Natal, Rio Grande do Norte, 1919.—About one-third kilometer south of new Central Depot, on hill just above priests' house, on monastery grounds, about 25 meters south of edge of hill, on second terrace above house, 13.45 meters north-northeast of larger and 10.95 meters northeast of smaller of two trees on terrace; marked by a wooden peg driven flush with ground. True bearings: signal pole on Matrice church, 48° 10'.3; west corner of priests' house, 168° 22'.1; east corner of railway-depot tower, 182° 02'.2; harbor-entrance light on old fort, 196° 40'.4; cross over entrance to hospital, 273° 35'.9; gable of Petropolis tramway station, 285° 16'.4.

Nova Olinda, Amazonas, 1917.—About 200 meters northwest of main house of Nova Olinda, southeast of small stream, on knoll near end of covered path leading from house; marked by stake.

Nova-Russas, Ceara, 1919.—About 300 meters southeast of railway depot, on opposite side of river, north of center of field used for making adobe bricks, and 54 meters southwest of main road east of field. True bearings: dividing line between red and white houses, 38° 01'.9; northeast corner of house on top of hill, 108° 17'.4; south gable of railway depot, 126° 20'.0; northeast corner of house nearest river, 165° 00'.9.

Obidos, Para, 1918.—Proximate reoccupation of C. I. W. station of 1911, near south corner of Praza do Bom Jesus, about 90 meters south of west corner of barracks, about 95 meters southeast of Bom Jesus Church, 60.30 meters north of near corner of house at corner of Justo Chermont and S. Mathues streets, 44.34 meters northeast of east corner of house at corner of Sant Anna and Justo Chermont streets, 14.67 meters and 16.77 meters north respectively from west and east goal-posts at south end of football-field; marked by a wooden peg. True bearings: cross on church, 126° 31'.9; point on west corner of barracks, 184° 57'.9.

Pernambuco (Recife), Pernambuco, 1919.—C. I. W. station of 1913 was no longer available on account of washing away of neck of sand on which it was placed. New station is about 4 kilometers west and 2 kilometers south of station of 1913, at old Derby, directly in front of middle entrance to Escola des Artifizes and 106 meters east of its lower steps, 110.4 meters southeast of trees near northeast corner of school building, 93.5 meters north-northeast of corner of wall on south side of Derby, and 49.7 meters west of rock formerly used as anchor for flagpole guy-line; marked by a sharp pointed stone buried beneath surface of ground. True bearings: southeast corner of school building, 63° 53'.9; northeast corner of school building, 119° 20'.5; south side of entrance in red wall, 170° 40'.8; ball gable ornament over red gable, 259° 02'.3; cross on old church, 298° 37'.3; ball on gable of house, 326° 47'.5.

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BRAZIL—*continued.*

Perseverança, Amazonas, 1914.—At barraca of Perseverança, on east (right) bank of Madeira River, 64.0 feet (19.51 meters) and 63.5 feet (19.35 meters) respectively from northwest and southwest corners of owner's house; marked by tack in top of tent peg driven flush with ground.

Pimenteira, Matto Grosso, 1914.—See Guaporé 4.

Pinheiro, Para, 1914, 1915, 1918, 1919.—Station *A* is exact reoccupation of Brazilian Magnetic Commission station of 1903, and C. I. W. station *A* of 1910, 1911, 1914, and 1915. In front of Church of St. Sebastian, 69.5 meters west of its southwest corner, 62.8 meters north of near side of shore end of government wharf and about 10 meters west of edge of steep river embankment; marked by concrete blocks 28 cm. square by 4.5 cm. thick built to a height of 76 cm., on top of which is a copper plate bearing data of Brazilian observations. Exact point is at edge of copper plate directly over second "R" in "DIRECTORIA"; 8.9 cm. from southeast edge of block and 11.8 cm. from northeast edge. True bearings: large brick chimney in Para, 1° 36'.3; top of ornament on top of Para water-tower, 2° 49'.6; ornament on far gable of pier-house, 42° 12'.

Station *B* is 15.6 meters from station *A* in line toward large brick chimney in Para.

Pombal, Amazonas, 1914.—At barraca of Pombal, on Madeira River, 52.2 feet (15.91 meters) northeast of northeast corner of lumber-shed, 15 feet (4.57 meters) south of edge of river, 21.6 feet (6.58 meters) west of post with iron ring, and roughly 40 yards (37 meters) northwest of owner's house; marked by tack in top of tent peg driven flush with ground.

Pontes e Lacerdas, Matto Grosso, 1914.—On west side of trail between Sao Luiz de Caceres and Matto Grosso, on south side of Guaporé River, in range with center line of bridge over Guaporé River, 82 paces south of left-hand center-pole of shed nearest bridge, 6.2 feet (1.9 meters) north of post projecting 3 feet (91 cm.) above ground, and 3 paces and 7 paces respectively southeast and northeast from dirt mounds; marked by tack in top of tent peg driven flush with ground. True bearing: flagpole on telegraph-office, one-fourth mile (0.4 kilometer), 321° 56'.6.

Porto Baguary, Matto Grosso, 1914.—On east bank of Paraguay River, at place known as Porto Baguary, half-day's launch travel up-stream from Corumba, in open space south of brick oven, between main living-house and shed northwest of house on bank of river, in middle of path leading from house to river, 53 paces northwest of north end of house, 46 paces east of near corner of shed, and 51 paces southeast of south corner of brick oven; marked by a 2-foot (0.6-meter) stake, having a tack in top, and projecting 1 foot (0.3 meter) above ground.

Porto Concepcion, Matto Grosso, 1914.—South of small tributary joining Paraguay River from northeast, just east of its junction with main river, 48 paces southeast of shed with tin roof near houses on bank of tributary, in a path leading from shed to large corral, about 250 paces northeast of main living house near steamer landing; marked by stake projecting slightly above ground.

Porto Curichão, Matto Grosso, 1914.—On east bank of Paraguay River, on a clearing with a few huts just east of up-stream river-landing, and 6 feet (1.8 meters) from top edge of bank; marked by a tack in top of a post projecting 1 foot (0.3 meter) above ground.

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BRAZIL—*continued.*

Porto Velho, Amazonas, 1914, 1917.—Exact reoccupation of C. I. W. station of 1914, and about 200 meters east of C. I. W. station of 1911, about 150 meters north of southeast corner of Hotel Brazil, about 600 meters east-southeast of southwest wireless tower and in range with wireless mast and down-pipe of westmost of 3 steel water-tanks, 295.5 feet (90.07 meters) southeast of center of down-pipe of eastmost steel tank, 72.32 meters northeast of geographical station established by Rondon Commission; marked by wooden peg. True bearings: small chimney, about 1 kilometer, 7° 51′.3; left edge of Hotel Brazil, 8° 22′.0; down-pipe of west steel tank, 107° 48′.7; thirteenth section from top of southeast wireless mast, 133° 05′.1.

Praia do Cigano, Para, 1915.—On sand spit on right bank of Araguaya River, about 75 feet (23 meters) from water's edge, about 0.5 kilometer south of a rocky ridge, or travessao, which extends across river.

Praia Flor do Calcho, Para, 1915.—Near south end of long Praia Flor do Calcho, immediately above travessao of same name, and about 50 yards (46 meters) southeast of water's edge.

Praia Joachim Alvez, Matto Grosso, 1915.—On west bank of west branch of Araguaya River, about 40 feet (12 meters) west of water's edge.

Putumayo 4, Amazonas, 1914.—On left bank of river, about 12 miles (19 km.) below Brazilian frontier, 22.5 feet (6.86 meters) southwest of southwest corner of deserted house and 7 feet (2.1 meters) south of point in line with south side of house.

Putumayo 5, Amazonas, 1914.—On left bank of river, about 35 feet (10.7 meters) west of a deserted house.

Quixada, Ceara, 1919.—About 400 meters east of railway depot, south of road leading from depot, in a field belonging to Senhor Joao Lucinda, 38.2 meters southwest of its northeast corner, 29.0 meters northwest of fence corner, in direction of Senhor Lucinda's house, and 56.2 meters southeast of south corner of house near road; marked by a wooden stake driven flush with ground. True bearings: inlet pipe on top of southern water tank, 700 meters, 50° 15′.0; cross on cathedral spire 900 meters, 86° 10′.0; "I" in "Quixada" on depot, 113° 04′.6; edge of rock on cliff to east, 3 kilometers, 254° 25′.3; west gable of house of Senhor Lucinda, 317° 15′.

Registro, Matto Grosso, 1915.—In line with north edge of street Coasta Marques, about 75 yards (69 meters) west of river, 21.2 feet (6.5 meters) southwest of small tree growing against near fence of a cattle-pen, 23.5 feet (7.2 meters) south of west corner of cattle-pen, and 216.4 feet (65.96 meters) north of large tree on north side of Fifth of March street. True bearings: right edge of house of Antonio Corvalhoes, 69° 38′.7; right edge government-service building Poasta Fiscal, 331° 14′.0.

Rio Branco, Acre, 1918.—See Empreza.

Rio das Mortes, Matto Grosso, 1915.—On Rio das Mortes Island in mouth of river of same name.

Rio de Janeiro, B, Rio de Janeiro, 1915.—An exact reoccupation of C. I. W. station *B* of 1910. True bearings: pavilion, Corcovado, 166° 46′.5; wireless telegraph-pole, 279° 52′.0; lighthouse on Raza Island, 326° 08′.6.

Rio Terreiro, Goyaz, 1915.—About 50 paces northeast of trail, measured from point on trail 134 paces northwest from Leopoldina end of bridge over Rio Terreiro, in bush on relatively open space commonly used for camping; 52 feet (15.8 meters) southwest of a medium-sized lixa tree, about 53 feet (16 meters) east of a borroza tree, and about 45 feet (13.7 meters) northeast of another medium-sized lixa tree; marked by peg driven flush with ground.

San Luiz, Para, 1918.—On right bank of Tapajos River, about 150 meters southeast of houses of San Luiz, and 15 meters northeast of path; marked by stake.

Santa Cruz, Goyaz, 1915.—In the jail square, 139.5 feet (42.52 meters) west of south corner of jail, 34 feet (10.4 meters) north of middle of Rua de Maio, 138 feet (42.1 meters) south of house of Casemir Rodriguez; marked by cross scratched in top of 5-inch (13-cm.) natural stone buried flush with ground. True bearings: right edge of house of Casemir Rodriguez, 200° 36′.5; right edge of house of Antonio Ribeiro, 233° 41′.0; right edge of jail, 290° 51′.5; right edge of small ell of house of Absebedes Texira, 356° 09′.6.

Santa Maria Nova, Goyaz, 1915.—On north side of Praia Street, in line with west side of Rua do Commercio, 50.9 feet (15.51 meters) north of northeast corner of last house on that street, a few feet south of high-water mark, and about 4 or 5 inches (10 or 13 cm.) west of east side of a stone 1.5 feet (46 cm.) square, set flush with ground and marked with cross chipped in surface.

Santarem, Para, 1918.—Close reoccupation of C. I. W. station of 1911, near north side of "Praza Republicana," about midway between east and west sides, on low elevation extending towards river, 35.7 meters north and 51.9 meters northwest of two lamp-posts respectively, 61.5 meters west of near corner of building on east side of plaza, and 33.9 meters from large tree standing on far side of bay-like depression to west; marked by stake. True bearings: ornament on southeast corner of roof of theater, 44° 27′.7; northwest corner of hotel at water table, 234° 44′.5; cross on church, 253° 18′.6.

Santo Antonio do Iça, Amazonas, 1914.—On left bank of Putumayo River, near its junction with the Amazon, on highest part of hill in rear of houses, 120 feet (36.6 meters) west of one house and 93 feet (28.3 meters) north-northeast of another.

São Joachim, Para, 1915.—About 75 yards (69 meters) west of front of church, 17 feet (5.2 meters) south of wooden cross, 64.9 feet (19.78 meters) southwest of portico of house of Mileto Mendez, 38.5 feet (11.73 meters) north of medium-sized lone tree, 105 feet (32 meters) northeast of northwest corner of portico of house belonging to Major Theotonio do Moresa, and 12 feet (3.7 meters) from middle of path along water-front; marked by wooden peg driven flush with ground. True bearings: right edge of portico of house of Major Theotonio do Moresa, 4° 38′.4; left edge of portico of house of Mileto Mendez, 189° 21′.9; cross on church gable, 272° 55′.0.

São Juaquim, Amazonas, 1914.—At barraca of Sao Juaquim, on west (left) bank of Madeira River, 20.2 feet (6.16 meters) east-northeast of northeast corner post of house; marked by tent peg driven flush with ground.

São Luiz de Caceres, Matto Grosso, 1914.—On west bank of Paraguay River, directly opposite town of Sao Luiz de Caceres, near center of grass-covered clearing, 16 paces from water's edge; marked by a 4-foot (1-meter) post, 4 inches (10 cm.) in diameter, pro-

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BRAZIL—*continued.*

São Luiz de Caceres, Matto Grosso, 1914—continued. jecting 2 feet (0.6 meter) above ground, with a copper tack in top. True bearings: right edge of powder magazine, 200 yards (183 meters), 211° 16′.7; tip of lamp-post, 150 yards (137 meters), 245° 31′.9; cross on church tower, 300 yards (274 meters), 297° 44′.6; tip of telegraph-pole at corner of cuartel, 200 yards (183 meters), 319° 43′.2.

São Miguel Rapids, Para, 1915.—At foot of rapids of Sao Miguel, on island of same name, just below sharp point of island about which deep-water channel of river makes an abrupt turn to left, and about 30 yards (27 meters) northwest of water's edge; marked by stake projecting several inches above ground. True bearings: middle of large flat mount of Serra do Cordueira, 153° 09′; highest visible peak, 186° 24′; flat-topped peak, 272° 39′; low peak, 285° 24′.

Sapucaia Island, Para, 1915.—See Espinhel.

Sobral, Ceara, 1919.—At southern extremity of Praça Senador Figuira, inside race-track inclosure of Sobral Jockey Club, 11.05 meters southwest of northwest corner and 7.65 meters southwest of southwest corner of watchman's house, 6.85 meters southeast of nearest point of outside fence, 1.90 meters north of fence along race-course, and 24 meters northeast of wooden telephone-pole south of race-course; marked by a brass-bound tripod stake, a hole in center marking exact point, left flush with ground. True bearings: lightning-rod on factory chimney, 57° 05′.6; wind-gage pole in Praça Figuira, 162° 13′.0; southeast corner of Alberto Amaral's house, 171° 26′.0; northern corner of cathedral, 263° 18′.4; west spire of cathedral, 264° 31′.8.

Tapirape River, Goyaz, 1915.—On high sand-bank about 4 kilometers north of Caraja village Tapirape, on east shore of west branch of Araguaya River, and about 1 kilometer south of mouth of the Tapirape River.

Timboteua, Para, 1918.—About 70 meters southeast of railroad station, in open space in front of church, about 50 meters south of railroad track, 22.83 meters from northwest and 22.34 meters from northeast corner of church, 8.62 meters north of base of wooden cross, and 22.7 meters south of trunk of tree; marked by wooden peg. True bearing: northeast corner of railroad station, 107° 42′2..

Urucurituba, Para, 1918.—About 225 meters north of left shore of Tapajos River, in pasture about 200 meters northwest of buildings, 25.5 meters south, 25.6 meters northeast and 37 meters northwest respectively of three large trees. True bearing: 328° 38′.5.

Vassouras, Rio de Janeiro, 1915 and 1919.—Three piers, *A* and *B* as in 1913, and *C* in 1919 only, were occupied for intercomparisons in absolute house of National Observatory of Brazil about 1 mile (1.6 km.) northeast of Vassouras; in 1919 outside auxiliary stations *F* and *G*, in line from pier *B* towards corner of distant house, and *E*, in line extended from pier *B* to *A*, were also established. True bearings: center pin of Observatory azimuth mark from *A*, 146° 40′.7; left edge of house on hill from *B* (1.6 km.), 174° 55′.9; near corner of house on hill from *B* (1.6 km.), 175° 16′.2.

Villa Nova, Amazonas, 1918.—On left bank of Tapajos River, about 150 meters southwest of house in open space on side of hill and 40.3 meters south of southeast corner post of wooden shed; marked by peg. True bearings: right corner of house, under eaves, 205° 59.7; gable of house across river, 4 kilometers, 289° 08′.′2.

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BRAZIL—*concluded.*

Vista Alegre, Amazonas, 1914.—On grass on upper bank at barraca Vista Alegre, on south (right) bank of Madeira River, about 75 yards (69 meters) northwest of church, and 12 paces northwest of lone orange tree; marked by tack in top of tent peg driven flush with ground. True bearings: right edge of roof of house across river, one mile (1.6 km.), 209° 49′.7; left edge of east porch post of owner's house, 200 yards (183 meters), 259° 11′.6; tip of cross on church, 298° 29′.3.

Xapury, Acre, 1918.—Near center of west half of plaza, 62 paces west of band-stand, 6 paces north of path; marked by a stake driven flush with ground. True bearings: gable of post-office, 166° 15′.6; wireless mast, 276° 25′.3; weather-vane on band-stand, 287° 54′.7.

CHILE.

Antofagasta, Antofagasta, 1917.—Approximate reoccupation of C. I. W. station of 1912, about 150 meters east of railroad, and almost due east of Calle Bolivar, in saddle just east of prominent point on third ridge south of large wooden cross which stands on a stone base, 3 meters south of summit of small knob to north, and 5 meters and 6 meters respectively from summits of small knobs to southeast and southwest; marked by stake left just below surface of ground. True bearings: chimney of east water-works, 31° 04′.0; right edge of right water-tank, 31° 16′.2; cross on church by Plaza Colon, 121° 16′.6; large nearby wooden cross, 191° 11′.1.

Arica, Tacna, 1914, 1917.—Close reoccupation of C. I. W. station of 1913. On sandy plain about 1.5 kilometers northeast of town, 118 feet (36.0 meters) southwest and 120.7 feet (36.79 meters) northwest of west and southwest corners respectively of cemetery wall; marked by an inverted brown glass bottle buried flush with ground and covered by a granite boulder about 20 centimeters in diameter. True bearings: flagpole on square tower in front of pest-house, 6° 06′.0; church spire in Arica, 83° 40′.4; south corner of foundation wall, 195° 17′.2; windmill in front of cemetery, 317° 06′.8.

Caldera, Atacama, 1917.—North of main section of town, near bathing beach, 30 meters west of west bath-house in row of bath-houses near band-stand, about 250 meters west of pier and about 39.6 meters northeast of vertical cliff of soft stone, 14.5 meters northeast of path, and 11 meters south of high-water line; marked by tent-peg driven flush with ground. True bearings: light on rock in harbor, 162° 35′.8; vertical west face or edge of distant rock, 200° 06′.8; light on passenger mole, 221° 16′.2; cross on church, 297° 24′.3.

Catalina, Antofagasta, 1917.—About 600 meters southeast of town, and about 150 meters west of hotel and freight station of Longitudinal Railway, 72 paces east of small railroad track, 15 meters south of top of small fill formerly used for nitrate railroad, 16.4 meters east of a nitrate prospect hole about 2 meters square and 2.5 meters deep, and 5 meters north of line of south side of freight station; marked by a wooden peg left slightly below surface of ground and covered with small nitrate rock. True bearings: center of taller of two smoke-stacks at nitrate oficina, 106° 40′.7; west corner of engine-house, 185° 35′.4; south side of water-tank, 235° 56′.9; northeast corner of Longitudinal Railway station, 290° 52′.7; pole on ridge at saddle, 338° 27′.0.

Chanaral, Atacama, 1917.—About 2 kilometers north-northeast of main part of town on high level plain between first and second football-fields east of ceme-

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CHILE—*continued.*

Chanaral, Atacama, 1917—continued.
tery, 105 paces east of cemetery fence, 120 paces north of large boulder near prospect hole about 1.5 meters square and 7 meters deep, in line with east edge of boulder and steel post beyond, also in line with south corner of cemetery fence and west edge of most westerly prominent rocky point in sandy ridge across bay, 3.92 meters east of boulder about 80 cm. in diameter, and 9.38 meters northwest of slightly larger boulder; marked by peg driven flush with ground and covered with pile of small stones. True bearings: west edge of base of brick chimney, 16° 22′.9; cross on church, 27° 06′.5; west edge of top of large brick chimney, 32° 17′.7; west edge west steel chimney, 66° 19′.5.

Concepcion, Concepcion, 1918.—Practical reoccupation of C. I. W. station of 1913. In low pasture land on east side of grounds of agricultural college, 32.6 meters south of wire fence along main road near entrance to school grounds, 33.7 meters west of fence along road to east, and 17.8 meters northeast of near corner of small bridge. True bearings: near corner of small bridge, 48° 22′.1; right-hand vase-like ornament on distant house, 91° 10′.1; post at northeast corner of inclosure, 240° 05′.1; telephone-pole on hill slope, 270° 09′.2.

Copiapo, Atacama, 1917.—About one-fourth mile (0.4 km.) southeast of railroad station, in pasture surrounded by high mud wall, southwest of Calle Carrera and between Calle Alamada and Calle Rancagua, at a point 30.9 meters northeast of southwest wall, 6.0 meters northwest and 8.0 meters southwest of irrigation ditch which forms an angle east of station, and 9.8 meters northwest of stump; marked by tent-peg. True bearings: cross on church, 41° 49′.3; small chimney on house on road by mountainside, 255° 30′.4; point on east end of row of mountains, 357° 36′.2.

Coquimbo, Coquibmo, 1917.—Practical reoccupation of C. I. W. station of 1913. Southeast of town, northwest of cemetery, on beach at a point about 42 paces south of road to Serena, about 100 meters northeast of and in projected line of east side of wall around small two-story house, and east of and in range with southeast corner of one-story stone house and north side of door in house beyond; marked by wooden peg. True bearings: cross on highest peak back of Coquimbo, 147° 59′.9; cross on distant round-topped hill, 297° 32′.3; pole on large house, 304° 45′.8; tip on large dome in cemetery, 347° 00′.9; west side of west tank toward cemetery, 347° 28′.1.

Coronel, Concepcion, 1917, 1918.—Three stations, designated *A*, *C*, and *D*, were occupied, in vicinity of United States Coast and Geodetic Survey station of 1907. Station *A* is a close reoccupation of C. I. W. stations *A* and *B* of 1912, on sandy plain about 1 kilometer southeast of town, about 200 meters northwest of slaughter-house, approximately in line with slaughter-house and chimney of soap factory, about 100 meters west of wagon road, on small flat knoll about 1.5 meters high and almost bare of vegetation, and nearly in line with fence at west side of second street east of soap factory; marked by peg. True bearings: smoke-stack at Lota, 24° 26′.6; chimney at Lota Lighthouse, 26° 02′.0; Puchoco Lighthouse, 104° 34′.0; chimney of soap factory, 150° 06′.1; north gable of slaughter-house, 335° 03′.7.

Station *C* is an exact reoccupation of C. I. W. station *C* of 1913, 18.76 meters south 32° 42′ west of station *A* of 1917; marked by peg. True bearings: chimney at Lota Lighthouse, 26° 01′.1; chimney of

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CHILE—*continued.*

Coronel, Concepcion, 1917, 1918—continued.
soap factory, 151° 41′.1; north gable of slaughter-house, 332° 00′.3.

Station *D* is about 80 meters south-southeast of U. S. Coast and Geodetic Survey station of 1907 and C. I. W. stations of 1912 and 1913, which were found unsuitable for reoccupation, on southeast end of highest and most easterly one of a group of sandy knolls, about 200 meters northwest of slaughter-house. True bearings: middle corner of middle house on hill above Lota, 19° 36′.1; west edge cornice at top of soap-factory chimney, 155° 04′.0; brick chimney east of town, 201° 47′.9; north gable of slaughter-house, 320° 17′.7.

Estacion Central, Tacna, 1914.—About 300 meters south of Arica–La Paz railroad, at end of a short ridge between two gullies, west one of which starts immediately behind a row of houses east of railroad shops; marked by a tack in peg flush with ground, witnessed by an iron rod 5 centimeters to south, projecting above surface about 15 centimeters.

Huasco, Atacama, 1917.—Close reoccupation of H. M. S. *Egeria* station of 1897. Northeast of town, about 400 meters east of shore-line, on flat sandy plain near commencement of large sand hummocks, about 700 meters northeast of large chimney of smelting works, about 150 meters northwest of reed swamp and small stream, 13 paces northwest of strip of bushy ground free from sand hummocks, 100 paces southwest of and approximately in range between first of larger hummocks and chimney of smelting-works, 13 meters south of top of hummock, 13 meters north of top of smaller flat hummock, and about 200 meters east-southeast of hummock through notch in top of which is visble right end of outer rocky islet; marked by wooden peg. True bearings: near corner of large chimney of smelting-works, 47° 54′.2; church spire, 56° 48′.4; light bracket on shore end of railroad pier, 73° 42′.2; new harbor light on post, 87° 19′.6; right of extreme outer rocky islet, 102° 30′.6; left of extreme distant northern point, 184° 14′.2.

Iquique, Tarapaca, 1917.—Close reoccupation of C. I. W. station of 1913. On Serrano Island, about 150 meters southeast of lighthouse, and near south edge of circular plat in center of island, 5.8 meters north of south edge of plat, and 22 meters southwest of center of low pile of stones; marked by wooden peg driven flush with ground and covered by a pile of stones about 40 centimeters in height. True bearings: base of pole on small house on west side of island, 120° 43′.1; tip of lighthouse, 155° 22′.0; center of large brick chimney, 259° 50′.7; cross on cathedral, 287° 48′.6; right spire on rim of gas-tank, 332° 10′.3.

Nivel, Tarapaca, 1917.—About 5 miles inland from Pisagua.

Pintados, Tarapaca, 1917.—About 800 meters southeast of Pintados, in center of road to cemetery, 5.8 meters southwest of center of main road, and 3.3 meters east of foot of steep hill; marked by a wooden peg driven flush with ground. True bearings: southwest corner of engine-house, 163° 39′.2; east side of tank, 187° 54′.0; southwest corner of Longitudinal Railroad station, 213° 34′.3; south corner of distant house on plain, 281° 30′.8.

Pisagua, Tarapaca, 1917.—About 2 kilometers north of Pisagua, about halfway on road to cemetery, on a point about 20 meters high projecting out into ocean, about 200 meters north of large oil-tank, 19.8 meters north of sixth fence post west of road, and 9.1 meters east of northmost high point in rocky ridge; marked

SOUTH AMERICA.

CHILE—*continued.*

Pisagua, Tarapaca, 1917—continued.
by a chiseled cross on top of a red granite block left 4 centimeters above surface of ground. True bearings: clock-tower, 20° 55′.6; east side of distant tank on hillside, 22° 01′.5; west side of large oil-tank, 110° 55′.4; prominent monument in cemetery, 177° 49′.3; cone on hillside, 298° 14 .6.

Puerto Montt, Llanquihue, 1919.—Close reoccupation of C. I. W. station of 1913. On northeast extremity of Tenglo Island in open grass-plot, about 100 meters north of two large red buoys, about 200 meters southeast of small house in fenced-in plot, and 32 paces southeast of barbed-wire fence; marked by tent peg covered by a black stone about 1 foot (0.3 meter) long. True bearings: near gable of small house at foot of hill, one-fourth mile (0.4 km.), 70° 54′.4; cross on church, 170° 07′.1; cross on church at plaza, 208° 07′.1; cross on church to right of church by plaza, 220° 11′.1.

Punta Arenas, Magallanes, 1919.—Exact reoccupation of Argentine Meteorological Office station *A* of 1913. On hill southwest of town, in field 30.9 meters northwest of fence west of main road; marked by wooden stake. True bearings: left wireless mast, 218° 04′.4; right wireless mast (of seven), 221° 18′.3; cross on church near plaza, 230° 01′.5; point on roof of large house near beach, 254° 39′.9; distant snow-capped pointed peak, 344° 32′.8.

Puquios, Tacna, 1914.—About 200 meters northwest of railroad water-tank, approximately in center of space at end of ravine which begins near water-tank and terminates at a pile of stones remaining there in railroad construction; marked by tack in peg beneath a rough granite stone, in form of truncated pyramid about 21 inches (53 cm.) across base and 9 inches (23 cm.) across top. True bearing: west edge of circular base of water-tank, 302° 39′.9.

Santiago, A, Santiago, 1917, 1919.—Practical reoccupation of C. I. W. station *A* of 1913. On west side of Santiago, in grounds of Quinta Normal, 53 paces west of football-field, 61 paces east of main road, 28 paces east of road through grounds, 7.8 meters north, 8.2 meters north-northwest, 13.4 meters northwest, and 13.8 meters west respectively, of bases of tree trunks; marked by wooden peg with brass tack in top. True bearings: whistle-pipe near steel chimney, 75° 27′.7; south side window in distant house, 82° 19′.2; south side lamp-post beyond football-field, 246° 21′.3.

Taltal, Antofagasta, 1917.—About 3 kilometers northeast of main plaza in town, about 200 meters east of shore in open plot surrounded by high fence, west of oil tanks of West Coast Oil and Fuel Company on side of hill and about 200 meters southwest of tanks of Union Oil Company, east of first rocky point north of factory and railroad yards, in range with a steel chimney distant about 175 meters and west side of large brick chimney beyond, 57 paces west of west wall of old stone conduit, 8 meters south of large round hole, 12 meters southwest of smaller one; marked by chisel hole in end of half-brick, flush with ground and covered by a round boulder. True bearings: near corner of small square tank on hill, 32° 37′.4; cross on church by main plaza, 40° 20′.0; cone on ridge, 289° 17′.7;.

Toco, Antofagasta, 1917.—About 150 meters northeast of railway station and hotel of Anglo Chilian Nitrate and Railway Company, Ltd., at edge of blasted area, 20 paces west of large blast-hole and 13 paces southeast of slightly smaller one; marked by small pebble driven into top of wooden peg, left flush with ground.

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CHILE—*concluded.*

Toco, Antofagasta, 1917—continued.
True bearings: west side of west water-tank, 75° 10′.9; south corner engine-house, 258° 08′.2; south side high water-tank at Longitudinal Railway station, 268° 51′.8.

Tocopilla, Antofagasta, 1917.—About 2.5 kilometers northeast of railroad station, east of main road leading north from town, about even with first cemetery, 7.3 meters and 6.0 meters from south and west sides respectively of football-field, and 23 paces southeast of nearest goal-post; marked by peg driven flush with ground. True bearings: west corner of base of transmission-line pole, 14° 24′.8; west side of west oil-tank, 72° 40′.8; southeast corner of cemetery wall, 115° 16′.8; north side of tank beyond railroad track, 267° 18′.5; southwest corner of house by track, 334° 58′.5.

Ultima Esperanza, Magallanes, 1919.—At Puerto Bories, in open space at foot of hill, 16.54 meters east of sheep-run, 25.9 meters southwest of top of large rock, and 23.6 meters west of wooden fence; marked by wooden peg.

Vallenar, Atacama, 1917.—On point of hill east of and overlooking valley in which town lies, between road leading to Huascualto and ruins of old mud house called "Casa de Polvora," 45 paces southwest of road, 20 paces east of edge of hill, and 15.4 meters northeast of east end of main section of mud wall of ruins; marked by wooden peg covered by a pile of boulders and mud blocks. True bearings: pyramid on ridge across valley near where road crosses ridge, 0° 09′.4; cross on church, 111° 18′.4; south corner of house across neck of valley, 150° 42′.2.

Valparaiso, Valparaiso, 1917.—Close reoccupation of C. I. W. station *A* of 1913. About 8 kilometers southeast of Valparaiso, between two roads out of city which unite near Miradero O'Higgins monument, on well-defined level spot on top of very prominent ridge about 250 meters northwest of monument, 7 meters from north edge, 5.5 meters from east edge, 10 meters from south edge, and 8 meters from west edge, of level spot; marked by wooden peg. True bearings: white stone on hillside, 53° 18′.6; cross on church in city, 147° 48′.0; letter A on monument, 341° 09′.4.

COLOMBIA.

Barrigon, Meta, 1914.—On right bank of river, at landing from which a mule trail leads to Villa Vicencia, 76 feet (23.2 meters) northeast of barbed-wire fence, and 90 feet (27.4 meters) from river bank; marked by peg driven flush with ground.

Bella Vista, Caqueta, 1914.—On south bank of Rio Orteguasa, 34 feet (10.4 meters) southwest of west building, and 12 feet (3.7 meters) west of point in line with west side of building.

Bogota, Cundinamarca, 1914.—Reoccupation within a few feet of C. I. W. station of 1909, in northeast corner of field belonging to Señor Manuel Jose Umaña, on east side of continuation of Calle 26 from Bogota to Salitre, about half mile (0.8 km.) past main cemeteries, 87.5 feet (26.67 meters) south of a ditch, and 104 feet (31.7 meters) west of street; marked by wooden peg. True bearings: middle of near face of El Guitron brick and tile factory, 311° 11′.3; tower of Iglesia Monserrate, 313° 00′.2; tower of Iglesia Guadalupe, 325° 56′.1; tower of Iglesia de la Piña, 343° 22′.7.

Culate de Pupures, Boyaca, 1914.—On left bank of river and between river and a large shed, 39 feet (11.9

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COLOMBIA—*continued.*

Culate de Pupures, Boyaca, 1914—continued. meters) from front of shed, 55 feet (16.8 meters) from its east corner, about 75 yards (69 meters) up-stream from a small house on same side of stream, and half mile (0.8 km.) southeast from two houses back in savannah.

El Baradero del Micaya, Caqueta, 1914.—On right bank of Rio Micaya, 23.3 feet (7.1 meters) south of southeast corner of larger of two sheds, and in line with east side of shed.

Florencia, Caqueta, 1914.—In small bamboo inclosure in southeast corner of block diagonally opposite northeast corner of plaza, 20.6 feet (6.28 meters) and 22.6 feet (6.89 meters) respectively north and west of fences along streets.

Guadalupe, Huila, 1914.—In pasture two blocks northeast of north corner of plaza, 186.5 feet (56.85 meters) northeast of bamboo fence along street on southwest of pasture, and 111 feet (33.8 meters) northwest of bamboo fence bordering a path very nearly in line of south side of street leading to northeast corner of plaza. True bearings: cross on dome of church near plaza, 15° 20′.0; center of gable of church on hill, 349° 23′.6.

La Reforma, Caqueta, 1914.—On left bank of river, 58.5 feet (17.83 meters) north of center of north side of house. This place has also been known as Tapacunti or Casa Cunti.

La Victoria, Caqueta, 1914.—On left bank of Rio Orteguasa, about half mile (0.8 km.) above its junction with Rio Caqueta, 50 yards (46 meters) west of two buildings near together, and about 35 yards (32 meters) north of north corner of another building.

Mata de Guanabano, Arauca, 1914.—On north bank of river, in small pasture adjoining last house at west end of row of eight houses, about 15 feet (4.6 meters) from river bank, and about 65 feet (19.8 meters) east of house.

Meta River 1, Arauca, 1914.—On north bank of river, 25 feet (7.6 meters) from edge of bank, and about 20 miles (32 km.) above abandoned Buena Vista plantation.

Meta River 2, Arauca, 1914.—On left bank of river, about 40 feet (12.2 meters) north of steep bank of river.

Meta River 3, Boyaca, 1914.—About 20 feet (6 meters) northwest of left bank of river, on low grass-covered flat submerged in rainy season.

Meta River 4, Vichada, 1914.—On right bank of river, about 65 feet (19.8 meters) east of river's edge, in edge of small savannah.

Neiva, Huila, 1914.—Close reoccupation of C. I. W. station of 1909, on first rise east of town, near last houses in center of prominent semicircular ravine Quebrada de Bache, between Calle 9 and Calle 10, 27 feet (8.2 meters) southeast of light bamboo fence and 38.5 feet (11.73 meters) northeast of heavier bamboo fence. True bearing: post at left edge of house, 349° 06′.4.

Orocué, Boyaca, 1914.—In east corner of block which is west of junction of streets two blocks northeast and one block southeast of plaza, 16 feet (4.9 meters) southwest of one street and 45 feet (13.7 meters) northwest of the other; marked by cross in top of tent peg.

Remolino del Migel, Meta, 1914.—On right bank of river, 92 feet (28.0 meters) east of largest house, and about 10 feet (3 meters) south of a point in line with north end of house.

SOUTH AMERICA.

COLOMBIA—*concluded.*

Tumaco, Cauca, 1916.—Practical reoccupation of C. I. W. station of 1909, on Morro Island, across harbor northeast from Tumaco, on point of land at north side of large inlet, separated from main part of island by a tidal channel and a tidal basin, about 130 meters west of house on main part of island, and 29.70 meters and 33.47 meters north and north-northeast, respectively, of only two coconut-palms on point of island; marked by a wooden peg driven flush with sand. True bearings: spire on clock-tower, 63° 36′.8; cross on center spire of new church, 69° 43′.4; north corner of house on main part of island, 297° 59′.6.

Villa Vicencia, Cundinamarca, 1914.—North of town in first large pasture on left after crossing bridge over stream, 151 feet (46.0 meters) northeast of stone fence along southwest of pasture, and 210 feet (64.0 meters) northwest of stone fence along road; marked by sharp corner of large rock projecting about 4 inches (10 cm.) above ground.

ECUADOR.

Guayaquil, Guayas, 1916.—About half mile (0.8 km.) north slightly east of C. I. W. station of 1908, which was unavailable, the site being covered by large reservoir On a level plain, about half mile (0.8 km.) north of water-tanks, about one-fourth mile (0.4 km.) west of river, about 300 meters east of a windmill on bank of a broad shallow ditch, south of ditch and east of point where it crosses a broad cattle-road running north from foot of hill, 114.2 meters northeast of sixth iron telephone-pole south of ditch being the sixth from gate at foot of hill, 81.3 meters east of seventh pole from gate or first north of ditch and 19.7 meters east of a tree; marked by a wooden stake. True bearings: windmill center, 84° 07′.8; pole on center Santa Ana, 330° 00′.2; C. I. W. station of 1908, 340° 07′; left edge of insane asylum, 350° 53′.0; left edge water-tanks, 352° 37′.5.

Quito, Pichincha, 1916.—Close reoccupation of C. I. W. station of 1908. On hill called Ichimbia, east of city, about 600 yards (0.5 km.) northeast along top of hill by road from a large house owned by Señor Julio Feran, at highest point on road, just east of a group of three mud gate-posts, two on west and one on east side of road, 5.8 meters east of nearest point of nearest mud post, 6.75 meters west of northwest and 8.65 meters northwest of southwest corner, respectively, of tile-roofed mud shed, and in extended line of north side of shed; marked by an inverted tent-peg driven flush with ground. True bearings: pillar on extreme top of hill, 64° 15′.0; church spire just visible over edge of hill and through hedge on mud fence, 89° 20′.0; waterfall across valley, 116° 25′.3; right side eucalyptus tree, 254° 11′.3; right edge of small house on top of hill, 337° 14′.3.

Riobamba, Chimborazo, 1916.—About 600 meters northwest of C. I. W. station of 1908, which was found unsuitable for reoccupation, the site being occupied by water-tanks. On small hill called Loma del Quito, about half mile (0.8 km.) northwest of railroad station and about one-third mile (0.5 km.) west of hill called Cerro del Quito, on which are two water-tanks, 24.2 meters east of a prominent rock, 17.2 meters south of a smaller rock, and 67 meters west of near corner of a mud foundation-wall; marked by a stone buried with its flat side flush with ground. True bearings: point of prominent peak (Cacha), 73° 29′.8; left edge of left tower of church, 102° 27′.2 left edge of left water-tank, 312° 07′.9; tower of cathedral, 314° 24′.8.

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GUIANA.

Cayenne, French Guiana, 1918.—Exact reoccupation of C. I. W. station of 1908. In public roadway near Botanical Gardens in eastern part of town, 236 meters south of south garden gate, 10 feet (3.0 meters) east and 31.5 feet (9.6 meters) west of edge of ditches beside roadway; marked by a copper rod 1.5 centimeters in diameter, projecting 1 centimeter from center of raised portion 32 by 33 centimeters and 2 centimeters high which is in center of concrete slab 1.54 meters square. True bearings: hole in top of concrete block 42 by 41 by 47 centimeters high, 26.18 meters distant, 0° 03′.4; steel post at east side of south garden gate, 167° 03′.6; hole in top of concrete block 42 by 42 by 45 centimeters high, 29.58 meters distant, 189° 55′.4.

Georgetown, British Guiana, 1918.—Close reoccupation of C. I. W. station of 1908. In grounds belonging to Botanical Gardens south of gardens, near center of former D'Urban race-course, 36 meters north of drainage canal along inside of course in old graded roadway which crossed course about 80 paces south of point on which former "Round Stand" stood, at a point 50.0 meters north of 7-wire fence along south side of field, 17 meters west of 8-wire fence which crosses field from north to south, about 4 meters west and 7.3 meters east respectively of ditches along sides of roadway; marked by concrete block 6 by 6 by 24 inches (15 by 15 by 61 cm.) projecting slightly above ground and lettered C. I. W. 1918, on top. True bearings: cross on small church, 91° 23′.1; top of large house, 600 meters, 104° 20′.2; ball below weather-vane on botanical house, 400 meters, 128° 58′.0.

New Amsterdam, British Guiana, 1918.—Exact reoccupation of C. I. W. station of 1908. North of city on grounds of lunatic asylum, near northeast corner of large quadrangle used as playground and athletic-field, 110 feet (33.5 meters) northwest of nearest corner of superintendent's residence, 71 feet (21.6 meters) south-southeast of a 24-inch (61-cm.) tree, 27.5 feet (8.38 meters) west-northwest of a 12-inch (31-cm.) mango, and 45.7 feet (13.93 meters) southwest of 18-inch (46-cm.) tree in corner of tract; marked by a cluster of three copper nails near center of top of wooden post 6 by 6 by 24 inches (15 by 15 by 61 cm.) set flush with ground. True bearings: northeast corner of a stockade, 25° 03′.8; northwest corner of foundation-pier of Victoria Block, 72° 15′.7.

Paramaribo, Dutch Guiana, 1918.—Two stations, designated *A* and *B*, were occupied, near river, east of city, on tract of ground occasionally used as a cricket-field. Main station *A* is exact reoccupation of C. I. W. station of 1908, 4.0 meters south of edge of a ditch at north side of field and 37.0 meters east of east corner of east foundation-post of old dressing-room formerly used by cricket-players; marked by original (1908) mark, a brass bolt in top of a hardwood post 6 by 6 by 24 inches (15 by 15 by 61 cm.) set almost flush with ground. True bearings: east gable of garrison magazine, about 520 meters, 45° 23′.0; east gable of public works building, 53° 50′.7; left side of lamp-post, 150 meters, 56° 55′.1; gable of district commissary, about 100 meters, 95° 06′.4.

Auxiliary station *B*, for declination only, is 45.95 meters from station *A*; marked by east side of hardwood peg. True bearings: east gable of garrison magazine, 523 meters, 50° 39′.4; station *A*, 128° 32′.3.

PERU.

Andomayo, Ancash, 1917.—About 4 kilometers west of Hacienda Andomayo, about 200 meters north of vertical rock cliff, 19 meters south of main road, on flat place

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PERU—*continued.*

Andomayo, Ancash, 1917—continued.

up steep bank, 2.6 meters back from edge of bank, in line with part of stone retaining wall, 4.4 meters west of south stone in wall, 26.2 meters northwest of large white boulder, and 3.2 meters east of edge of sink-hole; marked by wooden peg.

Arequipa, Arequipa, 1917.—The C. I. W. stations of 1912 were exactly reoccupied. Station *A* is in northeast corner of grounds of Arequipa branch of Harvard Astronomical Observatory, 10.48 meters from north mud and stone wall, 19.42 meters from east wall, 19.30 meters from northeast corner of house over 13-inch telescope; marked by brass nail in top of stake projecting 20 centimeters above surface. True bearings: northwest corner of observatory dwelling, 3° 07′.7; top of dome of church, 32° 39′.5; tower at Jesus Baths, 310° 47′.5.

Station *B* is 15.21 meters northeast of station *A*, in a line through station *A* and left corner of a distant house whose azimuth is 65° 14′.9; marked by a brass nail in top of stake projecting 20 centimeters above surface. True bearings: ball on church across valley, 336° 35′.9; church spire in Carmen Alto, 358° 34′.3.

Boca del Tupache, Loreto, 1914.—On left bank of Rio Tupache, about 1 mile (1.6 km.) above its junction with the Putumayo, 130 feet (39.6 meters) northeast of a house and 20 feet (6 meters) east of river bank.

Cerro de Pasco, Junin, 1917.—About 400 meters south of main office building of Cerro de Pasco Mining Company, and about 200 meters southwest of company hospital, on a flat place on hillside overlooking rear of a row of company dwelling-houses occupied by American employees, 71.60 meters south of east corner of most eastern dwelling in row, and in line with that corner and east corner of small outhouse in rear; marked by a wooden peg. True bearings: vertical edge of distant mountain, 157° 54′.9; west corner of main office-building, 207° 25′.1; spire on Theatro Hospital in town, 213° 10′.4; west edge of water-tank in town, 221° 56′.2; west edge of chimney on company hospital, 236° 05′.8; north corner of chapel on hill, 295° 22′.6.

Chimbote, Ancash, 1917.—Exact reoccupation of C. I. W. station of 1912. About one-third mile (0.5 km.) from landing pier and 1 block west of fence inclosing railway grounds, in line with fronts of houses on west side of street, and 73.73 meters north of northeast corner of nearest house; marked by brass tack in top of wooden peg. True bearings: farthest lamp-pole in street, 15° 41′.4; flagpole on mast of prominent house, 36° 36′.3; spire of distant chapel, 85° 59′.3; nearest corner of largest tomb in cemetery, 211° 07′.9; flagpole on slaughter-house, 239° 53′.5; northwest corner of railway-yard fence, 255° 20′.5; flagpole on railway depot, 345° 58′.6.

El Encanto, Loreto, 1914.—On ridge leading north from headquarters of Peruvian Amazon Co., Ltd., about midway between the headquarters building and a small cemetery to northeast, 45.5 feet (13.87 meters) east of a wire fence and 79 feet (24.1 meters) northeast of shed north of headquarters.

El Jubineto, Loreto, 1914.—On right bank of river, about 60 feet (18.3 meters) north of northeast corner of Captain's quarters, and in line with east side of house.

Hacienda Huayta, Puno, 1917.—Three stations were occupied, designated *A*, *N*, and *E*, in Hacienda Huayta, which is about 8.5 miles (13.7 km.) south-southwest of Lampa and about 2.5 miles (4.0 km.) north of Miraflores, on knoll of pasture land known as Cau-

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PERU—*continued.*

Hacienda, Huayta, Puno, 1917—continued.
casi, which is at an elevation of 100 to 125 feet (30 to 38 meters) above great flat valley lying between Lampa and Miraflores. Station *A* is about 1.7 miles (2.7 km.) east of buildings of plantation. True bearings: Coachico Peak, 84° 38′.6; Pilinco Peak, 123° 26′.8; dome of San Santiago Church in Lampa, 182° 14′.8; Youinuta Peak, 222° 29′.3; Cerro Yocara, 275° 53′.1; boundary marker, 276° 05′.0; tower of old building at Hacienda Miraflores, 348° 53′.4.

Station *N* is 482.01 feet (146.917 meters) north of station *A*, in line between station *A* and dome of San Santiago Church in Lampa. True bearings: Coachico Peak, 84° 00′.6; dome of San Santiago Church, 182° 14′.8; Cerro Yocara, 276° 21′.1; tower of old building at Hacienda Miraflores, 349° 15′.6.

Station *E* is 605.25 feet (184.481 meters) east-southeast of station *A* in line between station *A* and an unnamed peak. True bearings: Coachico Peak, 85° 01′.1; dome of San Santiago Church, 181° 29′.0; unnamed peak, 293° 07′.1.

Hacienda Putante, San Martin, 1917.—On south bank of Putante River, one-fourth mile (0.4 km.) west of Huallaga River, the hacienda serving as port for town of Uchiza, in field, about 150 meters west of southwest corner of main building of hacienda, 11.8 meters southwest of west corner and 12.7 meters west of south corner, respectively, of a small shed, 11.7 meters northeast of a prominent stump, and 17.1 meters northwest of a lone tree; marked by a wooden stake. True bearings: east corner of native house, 24° 37′; southwest corner of main building, 273° 02′.6.

Hacienda San Juan, Huanuco, 1917.—Southeast of road running along southeast wall of patio where cacao is dried, 4.93 meters from patio wall, 15.70 meters northeast of south corner and 37.40 meters southwest of north corner of wall; marked by a wooden stake. True bearings: ball on bell-tower of Hacienda San Francisco, 7° 42′.4; west edge of mud house at Hacienda Pampayaca, 11° 55′.8; gable end of house on hillside, 30° 59′.5; south corner of farthest house visible across valley, 311° 19′.8.

Huacho,, Lima 1916.—Close reoccupation of C. I. W. station of 1912. On high bank overlooking seashore, about 175 yards (160 meters) west of railroad station, at a point 118.2 meters southwest of southwest corner of building east of track and north of street, 105 meters west-southwest of single railroad track between two switches, 20 meters west of northwest corner of a large mound, 17 meters north of center of small knob-like mound, 20 meters east-northeast of brink of high steep bank above seashore, and 28 meters east of intersection of south edge of gully with brink of steep bank; marked by a shallow chisel mark on a triangular stone 4.5 by 5 by 5.5 inches (11 by 13 by 14 cm.), left flush with ground. True bearings: lone pole in pass to right of railroad track over ridge, 05° 41′.4; north corner base of distant cross, 16° 16′.2; point on middle of cliff, 127° 35′.0; old base of fallen cross, 135° 48′.2; large cross on mound, 170° 23′.4; church spire, 271° 49′.2.

Huacrachuco, Huanuco, 1917.—Near end of Calle Colcabamba by river, in middle of street, in area confined within retaining walls, 3.50 meters and 4.50 meters from face of walls to eastward and northward respectively, 5.50 meters and 5.80 meters from corners northeast and northwest respectively, and 27.30 meters northwest of intersection of south side of Calle Principal with east side of Calle Colcabamba; marked by a bone stake driven flush with ground. True bearings: outermost point of vertical cliff, 43° 03′.6; north corner of Señor Dassa's house, 130° 02′.1; east gable of house on hillside, 141° 29′.2; west corner of house across river, 198° 25′.4; northeast corner of chapel tower, 331° 53′.8.

Huancayo Observatory, 1919, 1920.—See description of Observatory page 000.

Huancayo, Junin, 1917, 1919.—The *primary* station was about 180 feet (54.9 meters) west-southwest of C. I. W. station of 1912, which was unsuitable for reoccupation, on west side of town, about 1,250 meters west of railway station, 1 block north of street leading from main plaza of town to entrance of cemetery, in corner of a field, 464 feet (141.4 meters) north of north corner of high mud wall surrounding cemetery, 45 feet (13.7 meters) south-southwest of line of eucalyptus trees just inside century-plant hedge, 74 feet (22.6 meters) south-southwest of face of mud wall on northwest side of road, and 74.6 feet (22.74 meters) from nearest corner of high mud wall to north-northeast of station; marked by a conical pile of boulders. True bearings: east gable adobe house, 26° 24′.8; south tower of church in Chongos, 41° 35′.0; tower of Iscos church, 54° 47′.1; tower of church in Chupaca, 98° 23′.8; tower of church at Huayao, 99° 51′.4; C. I. W. station of 1917 at Huayao, 102° 31′.8; tower of church in Marcatunac, 107° 48′.4; Matuhuatac hill, 113° 28′.7; tower of church in Vicso, 126° 46′.0; stone marker on peak at south end of valley, 354° 59′.3.

The *secondary* station of 1917 and 1919 was 951.3 feet (289.96 meters) south-southwest of main station and in line between *primary* station and east gable of adobe house, 103.1 feet (31.42 meters) from nearest point of south corner of mud wall about cemetery, 87.7 feet (26.73 meters) from face of third pier on wall, counting corner pier as one, and 109.4 feet (33.35 meters) from sixth pier, marked by a conical pile of boulders. True bearings: east gable adobe house, 26° 24′.8; south tower of church in Chongos, 42° 02′.8; tower of church in Iscos, 55° 33′.6; tower of church in Chupaca, 100° 25′.3; tower of church in Sicaya, 134° 32′.6; stone marker on peak at south end of valley, 354° 29′.0. The observer in 1919 states that *Huancayo secondary* is more likely to be available for future observations than *Huancayo primary*.

Huanuco, Huanuco, 1917.—About three-fourths kilometer west of Plaza de Armas, on slope of hill above west end of General Pardo Street. Station *A* is 90 meters west of point where water for city is taken from main canal, 3 meters south of edge of dry washout, and 44.55 meters west of north corner of house-ruins at end of General Pardo Street; marked by stake. True bearings: spire at hacienda Huanchupa, 12° 58′.6; base of cross on cathedral spire, 294° 42′.6; west gable of chapel across bridge, 303° 31′.9; southeast corner of chapel on hill, 308° 08′.2; cross on Santa Domingo spire, 323° 58′.5; spire on nunnery, 336° 19′.6.

Station *B* was occupied for making comparisons of instruments, 30.21 meters east of *A* in line toward cathedral spire.

Huayao, Junin, 1917, 1919.—In Pampa de Orhuazo about 1.5 kilometers west by south of Huancayo Magnetic Observatory site, about 2 kilometers southwest of C. I. W. station Pamparca *A* of 1917, 120.7 meters from southeast corner of stone wall around corral of Señor Melgar. True bearings: tower of church in Huayao, 938.8 meters, 59° 34′.8; Huayao eclipse station, 827.5 meters, 75° 30′.7; tower of church in Marcatunac, 144° 26′.3; stone marker on Cerro Cailpich, 263° 54′.4; east tower Ahuac cemetery, 325° 38′.6; tower of church in Iscos, 334° 12′.9.

SOUTH AMERICA.

PERU—*continued.*

Huayao, Eclipse, Junin, 1919.—About 2.3 kilometers west by south of Huancayo Magnetic Observatory site, 827.5 meters west by southwest of station Huayao 1917 and 1919, 268.4 meters north of church tower of Huayao. True bearings: tower of church in Huayao, 268.4 meters, 1° 47′.3; stone marker on Cerro Cailpich, about 5.0 kilometers, 262° 30′.1; north gable of adobe house used as magnetograph station, 176.5 meters, 357° 51′.4. This was absolute station for special observations in connection with solar eclipse of May 29, 1919. The self-recording magnetograph was mounted during May 25 to June 12, 1919, in north room of adobe building south of station, and special diurnal-variation observations with earth inductor were made in south room of same building on May, 28, 29, and 30, 1919.

Ica, Ica, 1917.—Close reoccupation of C. I. W. station of 1912, about half mile (0.8 km.) southeast of central plaza in southern end of soccer football-field, which lies between Alfonse Ugarte Shooting Club and Achirana River, 47.9 meters southwest of fence near river, and 33.3 meters northwest of a point midway between southern goal-posts. True bearings: knob on central dome of church, 58° 18′.3; flagpole on shooting club, 119° 34′.0; flagpole seen through gap in trees, 129° 25′.6; left edge of smoke-stack, 129° 39′.6; cross on top of large sand-hill, 137° 21′.1. Declination observations were made at a secondary station in line between main station and flagpole seen through gap in trees, and 142.7 meters northwest of main station.

Juliaca, Puno, 1917.—Exact reoccupation of C. I. W. station of 1912, in the pampa half mile (0.8 km.) southwest of town, in range with west side of ruined mud-plastered stone house, 42 feet (12.8 meters) north of its northwest corner, 66 paces from road running along west side of pampa; marked by a brass tack in top of tent-peg driven flush with ground and covered with stone about 1 by 1 by 2 feet (30 by 30 by 61 cm.). True bearings: central rod of railway company's westernmost windmill, 218° 20′.4; cross on La Merced Church, 223° 18′.2.

La Limena, Ancash, 1917.—About 300 meters southwest of depot of Tablones-Limena Railroad, on a flat open space near west end of valley, about one-third of way from Rio Santa to vertical cliff forming south wall of valley, 37.70 meters southeast of center of railroad track, 51.60 meters west of west corner of an adobe house, 20.93 meters northwest of nearest telegraph-pole, and 20.60 meters north of north corner of stone-rubble house; marked by a tent peg. True bearings: west point of large rock across river, 72° 45′.6; center of windmill, 233° 48′.6; west gable of railroad depot, 249° 43′.2.

Lima, Lima, 1914, 1916, 1917, 1918.—Three stations, designated *Hipodromo*, *B*, and *C*, inside race-course or hipodromo of Jockey Club of Lima, 2.5 kilometers southwest of palace, were occupied. Station *Hipodromo* is a close reoccupation of C. I. W. station of 1912, 115.5 meters from iron fence in front of grand-stand. As this station could not be recovered in 1918, stations *B* and *C* were established.

Station *B* is about 70 meters west-southwest of station *Hipodromo*, 108.5 meters northeast of east corner of brick foundation under bay window on southeast side of middle one of three hexagonal buildings within race-course, 1.7 meters southwest of extension of northeast face of small building southwest of grand-stand and 119.5 meters southeast of east corner of its brick foundation. True bearings: point on left end of distant house, 59° 44′.9; cross

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PERU—*continued.*

Lima, Lima, 1914—continued.
on church dome, 127° 11′.0; right corner of foundation of small building near grand-stand, 158° 55′.9; wireless tower on San Cristobal Hill, 215° 10′.5; right corner of railing on roof of house outside grounds, 342° 16′.0.

Station *C* is 49 meters southwest of station *B* in line with point on left end of distant house. True bearings: point on left end of distant house, 1,300 meters 59° 44′.9; cross on church dome, 129° 59′.8; right corner of foundation of small building near grand-stand, 173° 07′.0; wireless tower on San Cristobal Hill, 215° 20′.7.

Matucana, Lima, 1916.—Close reoccupation of C. I. W. station of 1912. Southwest of town, in hay-field on raised ground, about 75 meters south of roadside sanctuary, 4.5 meters north of third stone fence south of sanctuary, and 13.5 meters west of point of stone pile which is part of old retaining wall; marked by a cross cut on a stone 3 by 5 inches (8 by 13 cm.) buried flush with ground. True bearings: dome-like point on ridge at sky-line, 78° 46′.7; cross on high ridge, 194° 25′.7; east edge of sanctuary, 195° 43′.6; south corner of mud foundation wall, 281° 46′.1.

Mollendo, Arequipa, 1914, 1917.—Two stations were occupied. Station designated *1912*, occupied in 1912 and again in 1913, was reoccupied in 1914, about half mile (0.8 km.) north of dock, one-eighth mile (0.2 km.) west of main street, south of town cemetery, in line of southeast cemetery fence (later extended past station), 149.9 feet (45.69 meters) northwest of stone inclosure.

In 1917, on account of extension of cemetery fence, a new station designated *1917* was occupied, 80 meters southwest of station *1912*, in line with southeast fence of cemetery, 75.4 feet (22.98 meters) from south corner of cemetery, and 149.9 feet (45.69 meters) northwest of a stone inclosure; marked by brass tack in top of wooden peg driven below ground and covered with a stone. True bearings: cross on hill, 146° 17′.2; cross on east spire of Catholic church, 326° 09′.9.

Oroya, Junin, 1917.—About 130 meters southwest of C. I. W. station of 1912, which was found unsuitable for reoccupation. About 400 meters southwest of Cerro de Pasco railway depot and about 160 meters north-northwest of spring-house, on flat place on hillside above and 180 meters distant from railroad track, in field southwest of angle in stone walls, 31.35 meters from largest stone in wall to northeast, and 34.15 meters from largest stone in wall to east; marked by a wooden stake. True bearings: top of north edge of spring-house, 0° 39′.7; north edge of culvert buttress on hillside across river, 101° 47′.3; east edge of east chimney on Cerro de Pasco railway depot, 223° 39′.3; base of flagpole on gobernador's house, 231° 29′.9; top of right edge of water-tank, 245° 07′.8.

Pamparca, Junin, 1917.—Three stations were occupied, designated *A*, *B*, and *C*, on plateau known as Pamparca, which is between Huayao and Sicaya, and about 7 miles (11 km.) west-northwest of C. I. W. station at Huancayo. Station *A* is 3 kilometers northeast of church tower in Huayao, in grass roadway between Huayao and Sicaya, 1.5 feet (0.46 meter) from southern edge of roadway; marked by a conical pile of boulders about 20 inches (51 cm.) high. True bearings: southernmost tower on church in Ahuac, 18,206 feet (5.5 km.), 4° 30′.0; church tower in Huayao, 9,833 feet (3.0 km.), 59° 34′.6;

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PERU—*continued.*

Pamparca, Junin, 1917—continued.
church tower in Marcatunac, 101° 10′.4; church tower in San Antonio, 73,325 feet (22.3 km.), 187° 21′.8; church tower in Hualauyo, 41,687 feet (12.7 km.), 250° 04′.2; stone marker on Cerro Cailpich, 289° 46′.3; church tower in Iscos, 33,168 feet (10.1 km.), 345° 55′.2.

Station *B* is 869.9 feet (265.15 meters) northeast of station *A*, in a line through station *A* and church tower in Huayao, in second narrow grass path from station *A* at right angles to roadway, and about 65 feet (19.8 meters) north-northwest from center line of roadway; marked by a conical pile of boulders about 20 inches (51 cm.) high. True bearings: church tower in Huayao, 10,703 feet (3.3 km.), 59° 34′.6; church tower in Huayucachi, 319° 32′.7.

Station *C* is 975.4 feet (297.30 meters) southeast of station *B*, in line between station *B* and church tower in Huayucachi, in second narrow grass path from station *B* parallel to roadway, and is 1,415.5 feet (431.45 meters) east-southeast of station *A*, nearly in a line through station *A* to church tower in Marcatunac; marked by a conical pile of boulders, about 20 inches (51 cm.) high. True bearings: church tower in Marcatunac, 101° 18′.7; church tower in Huayucachi, 319° 32′.7. (Distances given were determined by triangulation.)

Pisco, Ica, 1917.—Exact reoccupation of C. I. W. station of 1912, about three-eighths mile (0.6 km.) north of mole, in inclosed plot of ground east of ruined smelter and in range with north wall of smelter, 40.6 meters and 29.8 meters respectively from north and east fences of inclosed plot; marked by a brass tack in top of wooden peg driven flush with ground and covered with heap of small stones. True bearings: east wireless mast, 1° 32′.5; west wireless mast, 19° 51′.8; flagpole on clock-tower, 23° 41′.9; knob on harbor light, 68° 56′.2; most southerly of three church towers in Pisco, 288° 57′.2.

Declination observations were also made at two secondary stations, designated as *E* and *N*; *E* is 169.4 meters east-southeast from main station and in line between main station and most southerly of three church towers in Pisco, and *N* is 222.2 meters north of main station and in line with east wireless tower and main station.

Putumayo 1, Loreto, 1914.—About 15 feet (4.6 meters) from north and west shores of a small island near right bank of Putumayo River, about 10 or 12 miles (16 or 19 km.) above mouth of Rio Igara-Parana.

Putumayo 2, Loreto, 1914.—On small low island near right bank of river.

Putumayo 3, Loreto, 1914.—On small sand-bar in midstream.

San Lorenzo Island (Callao Harbor), Lima, 1914.—The station of 1908 and 1912 was reoccupied. About 5.5 feet (1.7 meters) above and about 50 feet (15 meters) distant from ordinary high-water mark on beach, and approximately United States Coast and Geodetic Survey station of 1907; 79 feet (24.1 meters) and 67.4 feet (20.54 meters) from northeast and southeast corners of powder-magazine (marked "deposito de explosivos") which are in true bearing north 68°.7 west and south 34°.1 west, respectively, and 57.5 feet (17.53 meters) from door of magazine directly beneath flagstaff; marked by a small round stake driven flush with ground. True bearing: yellow church spire in Callao, 249° 14′.8.

Sayan, Lima, 1916.—About 0.5 kilometer east of railroad station, in line between railroad station and point of

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PERU—*continued.*

Sayan, Lima, 1916—continued.
conspicuous high mountain, in open field west of first road east of bridge leading south, 220 meters southeast of bridge, 46.22 meters west of tree in east corner of field, 41.03 meters southwest of first tree northwest of east corner, 53.80 meters northeast of tree at south corner of field, and 42.6 meters northwest of point on wall in line with tall tree on opposite side of road; marked by a wooden stake driven flush with ground. True bearings: east gable of railroad station, 75° 25′.5; tall tree beyond and slightly to right of railroad station, 77° 51′.0; corner of west abutment of bridge, 161° 46′.8; cross just south of highest point of mountain, 255° 24′.5.

Shiraca, Huanuco, 1917.—About 1 mile (1.6 km.) west of Santa Cruz, in yard of deputy governor of Shiraca, 8.20 meters southwest of northwest corner and 8.40 meters west-northwest of southwest corner, respectively, of stone house, 11.0 meters southeast of southeast corner of mud house, and 8 meters east-southeast of large rock near mud house; marked by a wooden stake. True bearing: pole on east side of house across valley, 22° 29′.9.

Tingo Maria, Huanuco, 1917.—West of Huallaga River and south of junction of Monzon and Huallaga rivers, on plantation of Señor M. Rosales, west of path, 12.6 meters north of north corner of north house, 25.1 meters northwest of west roof-pillar, and 24.7 meters northwest of north roof-pillar of east house; marked by a wooden stake.

Vitor, Arequipa, 1917.—On pampa, about 350 meters west of railway depot and about 175 meters northeast by north of railway track, 84.4 meters south of most prominent rock projecting from pampa at south edge of road leading to Mocoro, 35.4 meters west of west corner of small stone inclosure, and 163.9 meters northwest of fourth government telegraph-pole (black) westward from railway depot, counting one at depot as number 1; marked by a bone stake projecting 20 cm. from ground and covered by large heap of rocks. True bearings: telegraph-pole farthest out on pampa at curve in railroad below Vitor, 55° 44′.3; east edge of stone pier on hillock, 189° 47′.5; cross in shrine on hill, 256° 54′.3; west gable of railway depot, 280° 49′.1; cross in shrine on hill south of depot, 299° 28′.9.

Declination observations were made at two secondary stations designated as *W* and *N*; *W* is 470.3 meters true south, 67°.1 west, and *N* is 530.7 meters true south 178°.8 west of main station; both are marked by wooden stakes covered with heaps of stones.

Yangas, Lima, 1916.—Five stations were occupied, designated *A*, *B*, *C*, *D*, and *E*. Station *A* is about 1,300 meters east of Yangas, in highest cultivated field above steel foot-bridge which is about 800 meters on road up valley from Yangas, in northern corner of field, among large boulders, 64.80 meters east-southeast of tree at stone wall, 50.80 meters south-southwest of large stone projecting from nearest point in stone wall, 7.22 meters east of highest point of rounded white boulder and 8.10 meters west of highest point of black pyramidal-shaped boulder and in line between these boulders. True bearings: highest point of peak, 14° 01′.0; center of tower on church, 72° 15′.0; southwest corner of mud house by road, 309° 39′.9; cross by road, 344° 49′.4.

Station *B* is about 430 meters northeast of and above station *A*, in dry rocky valley, on west side of deeply eroded ditch, about 35 meters from foot of mountain, about 10 meters south of point where ditch and mountain meet, and about 6 meters west

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PERU—*concluded.*

Yangas, Lima, 1916—continued.
of edge of ditch; marked by large pile of stones. True bearings: cross by roadside, 11° 20′.9; top of mountain, 19° 32′.8; lower right corner of large stone, 36° 03′.0; station *A*, 36° 15′.3; rock tip on sky-line, 55° 53′.5.

Station *C* is in second field west of *A*, 373.2 meters distant, on central flat part of high point near north side of field, 146 meters west of mud and stone wall, 26.8 meters south of stone wall, and 16.3 meters south of near side of irrigation ditch; marked by a wooden stake projecting from ground. True bearings: station *A*, 277° 01′.2; corner of mud house by road, 300° 32′.9; cross by roadside, 312° 57′.0; highest point on mountain, 357° 48′.1.

Station *D* is about 850 meters southwest of station *A*, in point of cultivated field about 400 meters above Yangas, about 60 feet (18 meters) above roadway, 23.35 meters south of tree inside wall, 25.25 meters southwest of breach in wall, 16.30 meters southwest of highest point on upright rock, and 3.00 meters southeast of flat face of rock; marked by wooden stake projecting from ground. True bearings: station *C*, 224° 14′.3; station *B*, 235° 09′.1; station *A*, 244° 52′.7.

Station *E* is about 654 meters southeast of station *A*, in second field from road below lane leading northeast from road, in southern corner of field, about 21 meters from stone wall between lane and field, 3.7 meters from wall to southwest, 8 meters from largest stone in pile to north, and 5 meters from largest stone in pile to northeast; marked by a wooden stake flush with ground. True bearings: highest point of mountain, 43° 41′.3; station *C*, 122° 14′.7; station *A*, 136° 19′.2.

URUGUAY.

Colon, Colegio Pio, Montevideo, 1919.—Close reoccupation of C. I. W. station of 1913, near Lieutenant Schwerer's station of 1895, and Brazilian Magnetic Survey station of 1904, on grounds of Colegio Pio, 166.5 feet (50.75 meters) south of center of doorway of astronomical observatory building, 38.4 meters southeast of south corner of small brick building, measured in direction nearly perpendicular to roadway, 43.7 meters from telephone-post standing 7.1 meters from wire fence to southeast; marked by wooden stake about 2 feet (0.6 meter) long, driven 2 inches (5 cm.) below ground. True bearings: right edge of smokestack, 55° 49′.9; center of doorway, 177° 56′.2; spire on college chapel, 221° 40′.7; right corner of house, 314° 52′.5.

VENEZUELA.

Apure River, Apure, 1914.—On level sandy spot on south bank of river, between Caicara and San Fernando, nearer Caicara, about 15 feet (5 meters) from high water and about 20 feet (6 meters) from edge of wood.

Calaboza, Guarico, 1914.—In an inclosure on south side of last street north of more westerly of two churches, about half block farther east than church, about 35 yards (32 meters) from east edge of block, 39.5 feet (12.04 meters) south of street fence, and 32 feet (9.75 meters) east of a cactus and barbed-wire fence. True bearing: west edge of more westerly church, 18° 45′.5.

Caracas, Federal District, 1914.—The C. I. W. station of 1905, 1912, and 1913 was reoccupied. On same hill as observatory, 63.2 feet (19.26 meters) northeast of northeast corner of foundation on east side of observatory, 33.6 feet (10.24 meters) northeast of center

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VENEZUELA—*concluded.*

Caracas, Federal District, 1914—continued.
of round instrument pier, 43 feet (13.1 meters) east of center of large boulder, and 49 feet (14.9 meters) southeast of center of large rectangular pier; marked by hole in top of marble post 3.5 by 6 by 27 inches (9 by 15 by 69 cm.) projecting about 2 inches (5 cm.) above ground and lettered on top C. I. 1905. True bearings: gateway near west side of large inclosure, 175° 02′.6; east spire of Pantheon Nacional, 240° 14′.4; clock-tower facing Plaza Bolivar, 259° 48′.2.

Guaramaco, Apure, 1914.—Between buildings and river, 36.5 feet (11.13 meters) southeast and 64 feet (19.5 meters) south-southeast, respectively, from southeast and northeast corners of most northerly building of group, and 113.5 feet (34.6 meters) northeast of southeast corner of largest and only inhabited building.

La Urbana, Bolivar, 1914.—The C. I. W. station of 1913 could not be precisely reoccupied on account of erection of a barbed wire fence over spot. The new station is about 22 meters west-northwest of former station, on south bank of Orinoco river, 62 feet (18.9 meters) north of north side of street nearest river, 127.5 feet (38.86 meters) west-northwest of large tree in street line, and 153.5 feet (46.79 meters) northeast of northeast corner of house on south side of street.

Medana del Burro, Apure, 1914.—On savannah, nearly in line with north wall of most northerly of three buildings, and about 35 yards (32 meters) east of heavy wire fence in front of buildings.

Ortiz, Aragua, 1914.—Inside a small inclosure west of road leading from Villa de Cura, about opposite south end of posada, 10.0 meters and 12.6 meters respectively from north and west boundaries of inclosure.

San Fernando de Apure, Apure, 1914.—On opposite side of river from town, near stopping place for carts, about 16 meters from top of river bank, about 75 yards (69 meters) east of building known as Puerto Miranda, about 16 meters south of stockade, and 19.3 meters southeast of southwest corner of stockade. True bearings: center of corner doorway of building on west side of main plaza, 4° 39′.0; pyramidal tower of church facing Plaza Bolivar, 24° 19′.0; east stack on ice plant, 331° 39′.0.

Villa de Cura, Aragua, 1914.—In westward extension of street which passes north of plaza, about 300 yards (274 meters) west of buildings facing on this street, about 90 yards (82 meters) north of line of houses fronting on next street south, and 59 feet (18.0 meters) south of a lone tree. True bearings: dome of a lone building, 92° 19′.8; west edge of most prominent building to northward, 177° 03′.1; highest point of a hill, 316° 33′.7.

ISLANDS, ATLANTIC OCEAN.

CANARY ISLANDS.

Las Palmas, Grand Canary, 1915.—Practical reoccupation of station of 1912. On hillside about halfway between Port de la Luz and Las Palmas, nearly west of Hotel Metropole and English church, on excavated level place belonging to Elder Dempster and Co., at second turn in Jones's Road which ascends hill from north and south road at its foot, west of intersection of Jones's Road and a branch which continues to northwest, 32.14 and 10.95 meters from north corners of stone foundations of two benches to south and west respectively, and 53.20 meters south of stone boundary

ISLANDS, ATLANTIC OCEAN.

Canary Islands—*concluded.*

Las Palmas, Grand Canary, 1915—continued. marker standing north of branch road; marked by cross in top of small natural stone buried flush with ground. True bearings: lighthouse signal-staff on Isleta, 199° 57′.8; center corner Hotel Metropole chimney, 270° 20′.5; cross on convent, 291° 44′.0; church spire in Las Palmas, 314° 33′.0; chimney on Las Palmas power-house, 315° 22′.4; south cathedral spire, 324° 15′.9.

Santa Cruz, Teneriffe, 1914, 1915.—About 90 meters east of Hotel Quisisanna, on second terrace below hotel, about 45 meters from point where foot-path joins driveway, near eastern end of rectangular level area, 13.05 meters from wall on northeast, 5.90 meters west of lone palm tree, 4.60 meters northwest of lower terrace wall, 20.85 meters northeast of large boulder at south corner of rectangle; marked by projecting point of large stone buried in ground. True bearings: east corner of convent, 20° 29′.4; flagpole on hotel, 97° 49′.2; south corner of lone house on cliff, 238° 24′.0; Franciscan church spire, 304° 40′.2; west wireless tower, 344° 46′.0.

Fernando Po.

Santa Isabel, 1915.—On Point Fernandez, about halfway between town and end of point, 6.45 and 6.60 meters respectively south of southwest and southeast corners of square stone monument erected at grave of former British governor of island, and exactly in line with spire on governor's house and center of wireless tower. True bearings: wireless tower, 4° 01′.5; peak of Fernando Po, 7° 34′; spire of church in town, 15° 08′.2; monument near point light, 137° 13′.5; spire of church on mountain side, 343° 07′.2.

Iceland.

Akranes, 1914.—On Akranes peninsula 9.7 nautical miles (18 km.) northward across bay from Reykjavik, in an open grass-plot about midway between church and shore to south, 16.6 meters north of stone fence, 17.6 meters west of nearest corner of small house, and 13.4 meters south of a wire fence; marked by wooden peg. True bearings: church steeple below ball, 159° 56′.2; center chimney, last house across bay, 294° 16′.9.

Grotta, 1914.—In small level pasture belonging to town pilot, on point of land northwest of Reykjavik, about 3 miles (4.8 km.) west-southwest from Reykjavik station *A*, about three-eighths mile (0.6 km.) east-southeast of Grotta Lighthouse, 100 paces northwest of slaughter-house and dwelling, 75 paces east of galvanized-iron shed, and 22.4 meters east of concrete post about 21 centimeters square and 1.05 meters high, having in its top a round-headed copper bolt and on its south face a crown and letters G. S. engraved; marked by oak peg. True bearings: Grotta Lighthouse, 111° 38′.6; Reykjavik station *A*, 253° 17′.6; church spire, 298° 41′.2; observatory tower, 298° 44′.6.

Kialarnes, 1914.—On Kialarnes peninsula across bay from Reykjavik, very nearly in line from Hofwik Bay to Engey Island, 30 paces west of bank of Hofwik Fiord, 50 paces to bank in line with a group of very rugged rocks out a short distance southward, and 50 paces southeast of a sod farmhouse; marked by brass tack in wooden peg. True bearings: observatory tower, Reykjavik, 16° 18′.2; house across bay eastward toward Essia Mountain, 240° 07′.3.

ISLANDS, ATLANTIC OCEAN.

Iceland—*concluded.*

Reykjavik, 1914.—Two stations, designated *A* and *E*, were occupied on an open grass-plot on Engey Island, about 2 miles (3.2 km.) across harbor northward from Reykjavik. *A* is about 100 yards (91 meters) northwest of dwellings of two farmers who own the island, about same distance from north end of island, 90.08 meters northwest of small red light beacon standing near farm dwellings, and 32.51 meters northeast of a point in line between small red light beacon near farm dwellings and similar beacon at north end of island; marked by wooden stake. True bearings: observatory tower flagstaff, 6° 27′.1; Catholic church spire, 26° 55′.8; Valhusbakki Beacon, 57° 20′.1; Grotta Lighthouse, 78° 27′.7; red light near north end of island, 117° 40′.8; church spire at Akranes, 153° 05′.4; nearest corner red and white house, 289° 51′.9; cleft in mountain, 308° 17′.1; red beacon near dwellings, 316° 50′.3.

E is 33.30 meters west-southwest from *A* on azimuth line to Grotta Lighthouse; marked by wooden stake. True bearings: observatory-tower flagstaff, 6° 05′.6; Catholic church spire, 25° 14′.4; Valhusbakki Beacon, 57° 13′.1; Grotta Lighthouse, 78° 27′.7; red light near north end of island, 120° 49′.5; church spire at Akranes, 153° 10′.3; nearest corner of red and white house, 289° 40′.1; red light near dwellings, 305° 50′.9.

Three auxiliary stations, designated *B*, *C*, and *D*, were also occupied. *B* is 52.45 meters east-southeast from *A*, and in range between *A* and corner of red and white house; *C* is 72.3 meters from *A*, in azimuth 128° 17′.1; *D* is 104.8 meters southwest from *A*, and in range between *A* and Valhusbakki Beacon.

Videy Island, 1914.—On a small grassy knoll, at most westerly point of island, 12 paces and 10 paces from precipitous edge of island to north and east respectively. True bearing: station *A* on Engey Island, 85° 44′.9.

Madeiras.

Funchal, A, 1914.—Probably about 35 feet (10.7 meters) northeast of C. I. W. station *A* of 1909. Near center of military parade-and drill-ground of College barracks, 66.3 feet (20.21 meters) southeast of ruined wall of hut at back of drill-ground, and 86.3 feet (26.30 meters) northeast of wall along southwest side of grounds. True bearings: Cathedral spire, 315° 50′.8; corner of wall seen through entrance gate, 328° 02′.2.

Station *C* of 1909 was reoccupied as nearly as possible. It is on a level spot about 60 feet (18 meters) above sea-level near sea-cliff about 3 miles west-southwest of station *A*, and about one-eighth mile (0.2 km.) east of large fish cannery, between sea-cliff and a retaining wall about 4 feet (1.2 meters) high, west of a concrete hut, and is so situated that Sail Rock is seen in line with right edge of hut.

St. Helena.

Longwood, A, 1920.—Exact reoccupation of C. I. W. station of 1913. On lawn in front of house in which Napoleon died, 53.05 meters west-southwest of southwest corner of north post of gate, 34.1 meters northwest of west corner of masonry support for three water-tanks, and 13.1 meters due south of point in line with flax hedge; post marking site had decayed and point was further marked by oak stake bound around top with brass ferrule. True bearings: west edge of doorway in single house across valley, 3° 05′.6; flagstaff at High Knoll Fort, 102° 30′.4.

ISLANDS, ATLANTIC OCEAN.

SOUTH GEORGIA

Edwards Point, King Edward Cove, 1916.—On southeast side of Edwards Point, about 6 feet (2 meters) above water, on flat piece of ground, about 30 to 50 feet (9 to 15 meters) wide, bordering sloping beach between Edwards Point Light and English magistrate's office, at a point between path and beach about 90 paces from light and about 1 pace southeast of line from light to magistrate's flagpole; marked by 3-inch stub projecting about 4 inches (10 cm.) above ground, with brass screw marking center. True bearings: south one of two ranges, prominent squared and painted poles, set by Captain Shackelton for convenience of vessels testing their compasses, 40° 35′.0; north range, 43° 41′.5; Edwards Point Light, 71° 06′.4; spire of Lutheran church, 112° 32′.2; base British flagstaff, 250° 01′.7.

WEST INDIES.

Bridgetown, Barbados, 1919.—Exact reoccupation of C. I. W. station of 1908, in former Naval Hospital grounds, now privately owned. about 300 feet (91 meters) southeast of C. I. W. station of 1905 and in line with this station and southwest corner of stone garage, 121.8 feet (37.12 meters) west-northwest of inside corner in stone wall along east boundary of grounds, and 26.8 feet (8.17 meters) nearly north of Transit of Venus pier; marked by a limestone post about 6 by 10 by 20 inches (15 by 25 by 51 cm.), projecting slightly above general surface of ground, projecting part being thinly coated with cement, with top inscribed C. I. 1908, with drill-hole indicating exact point. True bearings: tip on band-stand (The Rocks), 27° 41′.0; tip on red brick house, 83° 07′.9; flagpole on hotel, 93° 27′.5.

Havana, Cuba, 1916.—Exact reoccupation of C. I. W, station of 1905 and 1908, designated as Havana. Villa, in suburbs of Havana, about 3 kilometers south of main buildings of Colegio de Belen, at the villa Asuncion de los Jesuites, about 100 meters west of seismic observatory, on concrete observing pier about 1.4 meters high; marked by intersection of three foot-screw grooves on top of pier. True bearings: tower on house behind north side of hill, 108° 25′.5; eastern tower of railway station, 177° 22′.9; Belen cupola, 179° 29′.9; Belen College Church spire, 179° 52′.8.

Kingston, Jamaica, 1914.—The U. S. Coast and Geodetic Survey station of 1905 was again reoccupied. About 2 miles (3 km.) west of city on farm owned by Mr. Clough, about 250 feet (76 meters) from shore and almost due north of Port Royal, on Kingston side of harbor, about 340 feet (104 meters) from old house near shore; marked by a 6 by 6 by 30-inch (15 by 15 by 76-cm.) stone set to project slightly above ground and having a drill-hole at center; the letters, U. S. C. and G. S. 1905, have been obliterated by weathering. True bearing: Commodore's Lookout Tower at Port Royal, 29° 25′.2.

ISLANDS, INDIAN OCEAN.

CEYLON.

Colombo, 1918, 1920.—Station *A* of 1911 was reoccupied in 1918, and stations *A* and *C* in 1920, in western part of grounds of Colombo Observatory, in Cinnamon Gardens off Buller's Road. Station *A* is 108 feet (32.9 meters) southwest of fence, 164 feet (50.0 meters) southwest of southwest corner of office building, and 80.6 feet (24.57 meters) west of thermometer shelter; marked by concrete block 5 inches (13 cm.) square on top and lettered C. I. W. 1911. True bearings: northwest corner of lunatic asylum, 55° 41′.2; left corner near eaves of Cricket Club grand-stand, 123° 49′.5; lower tip of small white upright over east gable of "Grasmere", the surveyor-general's bungalow, 177° 26′.0; nearest corner of office building, 212° 07′.

Station *C* is 84.62 feet (25.79 meters) south 177° 26′.0 west from *A*.

MADAGASCAR.

Ambalavao, 1920.—On unoccupied ground east of London mission property, on eastern outskirts of town, near northeast corner of grove of eucalyptus trees, 25.25 meters southeast of northeast boundary stone on south side of main road marking northeast corner of mission property, 18 paces south of main road, 19 paces east of cactus hedge; marked by granite block 14 by 15 by 40 centimeters, its top projecting slightly above surface of ground and bearing the inscription I. F. on face. True bearings: stone at northeast corner of London mission property, 144° 17′.8; cleft in rock of mountains, 323° 27′.2; doorway of house on hillside, 600 meters, 338° 34′.0; geodetic beacon on Mount Andraitongy, 10 kilometers, 355° 36′.1.

Ambositra, 1920.—Two stations were occupied. Station *A* is south of residency grounds, between flower-garden and tennis-court, on grounds of Mr. Hugh Hanning, in line with two end posts of court, 14.17 meters east of nearer post, and 1.96 meters east of top of steps leading down to tennis-court; marked by granite block 23 by 23 by 45 centimeters, set flush with surface of ground, and marked C. I. W., 1920 with red paint. True bearings: south gable end of Mr. Hanning's office, 50 meters, 59° 22′.8; beacon on mountain to east, 6 kilometers, 303° 47′.8; north gable end of church in valley, 2 kilometers, 315° 13′.4.

Station *B* is in valley south of town, about 1.4 kilometers southeast of *A*, within race-course, near north end, near center of small circular track for training horses, in line with north end of race-stand near northwest turn of track and 130 paces southeast of its corner, 80 paces and 95 paces from inner edge of track toward northeast and southeast respectively; marked by granite block 20 by 20 by 55 centimeters, projecting slightly above surface of ground and lettered C. I. W., 1920 with red paint. True bearings: near gable end of house, 1 kilometer, 24° 35′.8; top of tower of church, 1 kilometer, 91° 03′.3; east end of north wall of race-stand 118° 25′.1; top of gateway over prison, 800 meters, 146° 37′.1; geodetic beacon on hill, 12 kilometers, 202° 21′.7.

Ampasindrasoa, 1920.—In north outskirts of village, on narrow tract lying between roads to Betroka and Benenitra, about 4 paces southeast of edge of road to Benenitra, 9.30 meters southwest of tree, and 37.10 meters northeast of west veranda post of rest-house. True bearings: east veranda post of rest-house, 24° 05′.6; west veranda post of rest-house, 36° 22′.8; prominent tree across river, 0.5 kilometer, 180° 46′.4.

Andriba, 1920.—East of town on open grass-land 21 paces east of main motor road from Tananarive to Maevatanana, 37.81 meters north of northeast veranda post of rest-house for travelers (Gite d'Etape). True bearings: northeast veranda post of rest-house, 13° 35′.3; east end roof of hotel, 118° 30′.6; beacon on Mount Andriba, 10 kilometers, 194° 17′.9.

ISLANDS, INDIAN OCEAN.

MADAGASCAR—*continued.*

Ankatrafay, 1920.—In middle of main road from Betroka to Benenitra, east of village, 93 paces along road southeast of rest-house, 20.20 meters south of large monolith which serves as a memorial tomb. True bearings: distant peak, 20 kilometers, 2° 22′.1; southeast corner of rest-house, 126° 57′.2; bottom of monolith, 195° 01′.0; village flagstaff, 2 kilometers, 275° 44′.8.

Ankazobe, 1920.—Near middle of town in garden of tribunal which is surrounded by a low mud wall and lies between market and treasury, exactly in line with north side of secretary's residence and west side of tribunal, 39.40 meters southeast of southwest corner of Tribunal and 28.00 meters west of east garden wall; marked by a block of gneiss, 20 by 25 by 35 centimeters having a hole in top to mark exact point. True bearings: southeast corner of administrator's office, 74° 40′.1; southwest corner of market building, 80 paces, 126° 49′.5; southwest corner of Tribunal, 141° 31′.9; west corner of secretary's house, 233° 19′.7; outer edge northwest veranda-post of treasury, about 40 meters, 293° 43′.8.

Antsiafabositra, 1920.—Near base of hill, 142 paces along path leading east from hotel, 67 paces south of stream, 5 paces west of point where native path crosses ditch along side of hill. True bearings: near gable of most northerly house on hill, 300 meters, 26° 51′.3; telegraph-pole near south end of post-office, 75° 31′.1; east gable of hotel, 102° 43′.2.

Antsirabe A, 1920.—In middle of large garden of Roman Catholic mission, south of residency, on path near north edge, southeast of pond in northeast intersection of two pathways, 21.85 meters northwest of northwest corner of brick building, 40.40 meters east of northeast corner of church. The location of Pére Colin's station of 1901 is now covered by priests' house about 40 meters west-southwest of present station. True bearings: east gable of priests' house, 65° 04′.8; northeast corner of church, 102° 14′.5; northwest corner of brick building, 339° 38′.1; northwest corner of brick building, 359° 26′.6.

Antsirabe, B, 1920.—Near north end of race-course, on lawn in front of hot baths, in line of southeast wall surrounding baths, 39.70 meters northeast of east corner of wall, 4 paces southwest of race-track; to be marked by stone projecting slightly above surface of ground and lettered C. I. W. 1920. True bearings: east corner of wall around baths, 31° 02′.0; top of tower on baths, 70 meters, 66° 45′.6; top of spire of Roman Catholic church, 700 meters, 312° 04′.0; top of steeple of Protestant church, 1 kilometer, 333° 36′.2.

Benenitra, 1920—In the Place Publique, 61.80 meters west of north corner of fence inclosing buildings of the native guard, 18.50 meters northeast of large tamarind tree near middle of grounds; marked by cross cut in top of block of sandstone, whose upper face is 20 by 10 centimeters, projecting 8 centimeters above surface of ground. True bearings: nearby tree, 53° 27′; sign-post at cross-roads, 100 meters, 68° 38′.1; memorial tomb of French soldiers, 120 meters, 97° 05′.9; conspicuous peak, 5 kilometers, 231° 52′.5; north corner of fence of native guard compound, 257° 43′.8; top of telegraph-pole near north corner of post-office, 200 meters, 334° 53′.5.

Betafo, 1920.—Proximate reoccupation of Pére Colin's station of 1901, on public square, about 200 meters north of Catholic mission, about 200 meters south of hotel, 6 paces and 12 paces from roads bounding square on west and south, respectively, and 33.80 and 31.20 meters from northwest and southwest corners, respectively, of the nearer of two market buildings; marked by granite block, 17 by 18 by 55 centimeters, set with top face slightly above ground. True bearings: bottom of inner side of east pillar of mission gate, 32° 07′.5; bottom of west side of house on hillside, 2 kilometers, 115° 58′.8; outer edge of southeast veranda pillar of hotel, 200° 52′.9; northwest pillar of west market building, 270° 29′.6; south edge of band pavilion, 100 meters, 325° 02′.5.

Betroka, 1920.—In circular park called Place Iakora, 25.10 meters southeast of base of kiosk near middle of park, and 49.40 meters southwest of sign-post at point where road from Farafangana enters park; marked by stone block 14 by 14 by 45 centimeters, projecting slightly above surface of ground. True bearings: top of cross on church, 80 meters, 80° 21′.0; top of kiosk, 146° 08′.8; sign-post on road to Farafangana, 241° 57′.4; tree at far end of avenue, 400 meters, 317° 21′.2.

Fianarantsoa, 1920.—Two stations were occupied. Station *A* is on grounds of London mission which is situated on southern slope of Mount Kianjasoa, near north corner of triangular plot southeast of secretary's residence, 15 paces southwest of north apex of triangle, 9 paces and 8 paces from cactus hedges along paths toward northwest and east respectively; marked by block of gneiss 10 by 13 by 47 centimeters, projecting slightly above surface of ground. True bearings: prominent monument on sky-line, 5 kilometers, 40° 15′.6; near gable end of mission-secretary's residence, 114° 28′.7; east edge of west pillar of gateway, 20 meters, 206° 09′.8; steeple of church in town, 1 kilometer, 330° 08′.0.

Station *B* is west of town, near middle of race-course, in rice valley, in line with south side of south race-course building of two, at west side of track, 124.85 meters southeast of nearest corner of building. True bearings: trigonometric beacon on hill, 2 kilometers, 39° 34′.7; bottom of south side of south race-course building, 112° 33′.9; trigonometric beacon on mountain, 10 kilometers, 164° 03′.8; south gable end of London mission residence, 2 kilometers, 268° 21′.9; church steeple on hill, 3 kilometers, 286° 13′.7; north gable end of large house with red roof, 2 kilometers, 324° 08′.9; trigonometric beacon on mountain, 15 kilometers, 350° 00′.0.

Fihaonana, 1920.—South of town on the "Terrain d'Exercise," a triangular tract lying in junction of footpath from Tiamanananazy with motor road from Tananarive, about 200 meters east of residence of chef de poste and about 400 meters southwest of French Protestant mission, 34 paces south of tree south of motor road opposite large stone marked "H.6," 24 paces east of footpath. True bearings: old tomb on hill, 10 kilometers, 12° 42′.3; west gable residence chef de poste, 100° 12′.7; lightning-conductor on roof of mission, 202° 16′.7; geodetic beacon on hill, 2 kilometers, 234° 11′.8.

Ihosy, 1920.—Near middle of public square, on line joining flagstaff and lone mango tree, 16.75 meters south of flagstaff, and 15.10 meters north of mango tree; marked by block of gneiss 20 by 12 by 115 centimeters, with top projecting about 10 centimeters above surface of ground. True bearings: lone mango tree, 10° 24′; near gable end of cottage, 80 meters, 149° 55′.7; flagstaff, 190° 26′; near corner of Assembly Building, 72 paces, 335° 52′.7.

Lalana, 1920.—Near southwest end of village, south of rest-house inclosure, in line with southwest fence of

ISLANDS, INDIAN OCEAN.

MADAGASCAR—*continued.*

Lalana, 1920—continued.
inclosure, 18.25 meters southeast of its nearest corner. True bearings: near corner of fence of rest-house, 128° 31′.6; southeast veranda post of rest-house, 163° 20′.3.

Maevatanana, 1920.—Two stations were occupied. Station *A* is north of town, on summit of small round hill, about 100 meters west of cemetery, and about 300 meters northwest of hospital, in a native path which crosses hill. True bearings: south end of store shed of Compagnie Occidentale, 44° 09′.9; south corner of cemetery, 246° 29′.7; east end roof of east hospital building, 300° 56′.6; spike on west end roof of European hospital, 400 meters, 347° 00′.7.

Station *B* is about 1 kilometer southwest of station *A*, on prominent hillock, about 0.5 kilometer north of bridge on main road to Tananarive, west of town; reached by following native track leaving main road at stone marked 345.9 km. True bearings: north gable of mission church, 1 kilometer, 11° 37′.2; prominent bushy tree near village, 41 paces, 199° 14′; flagstaff on office of Compagnie Occidentale, 600 meters, 249° 24′.3; outer edge of east pier of bridge over main road, 341° 26′.8.

Mahatsinjo, 1920.—On prominent hilltop north of village, about 0.5 kilometer north of post-office, and about 150 meters east of church near main motor road, exactly in line with east side of inclosure around tomb of M. Durand, 16.70 meters south of southeast corner of inclosure; marked by wooden stake covered with cairn of broken limestone. True bearings: north gable of hotel in village, 6° 22′.0; trigonometric beacon on mountain, 6 kilometers, 84° 21′.9; north end roof of church, 88° 24′.8; southeast corner post of inclosure around tomb, 182° 06′.6.

Majunga, 1920.—Two stations were occupied. Station *A* is exact reoccupation of French Hydrographic Service station of 1900; it is in middle of ruins of old Malgash tomb known as "L'Ancien Signal Tombeau," on ridge called "Plateau des Tombes," about 2 kilometers north-northeast of town; marked by stone bearing letters S. H. True bearings: staff on bank in town, 2 kilometers, 21° 10′.3; top of "Chateau d'Eau" (water-tower), 1 kilometer, 51° 42′.9; lighthouse on Alligator Point, 2 kilometers, 80° 37′.1; lighthouse across harbor, 88° 24′.1; stack of meat factory at Boanamary, 20 kilometers, 357° 52′.7.

Station *B* is on beach, about 1.2 kilometers southwest of station *A*, in line with north side of administrator's residence, 9.65 meters from a cross cut in sea-wall 60 centimeters above ground; marked by block of limestone whose exposed portion is 8 by 8 by 8 centimeters, bearing cross in top, with three letters, C, I, W, on three sides, respectively. True bearings: lighthouse on coast, 93° 20′.2; staff on top of wireless mast, 0.5 kilometer, 155° 16′.2; north flagpole on Governor's residence, 264° 56′.0; lamp-standard in sea-wall, 0.5 kilometer, 358° 12′.4.

Tananarive, 1920.—Within race-course near north end of Place Richelieu, about 150 meters east of race-course buildings, 9 paces east of bank of small stream, 18.45 meters northeast of north tree of row along stream, 7.10 meters west of small tree; marked by stone 10 by 10 by 50 centimeters, projecting about 10 centimeters above surface imbedded in cement, and marked C. I. W. True bearings: top of judges' box, 73° 08′.5; west end roof of college, 164° 46′.0; cross on west tower on cathedral, 256° 13′.1; flagstaff on queen's palace, 311° 49′.6.

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MADAGASCAR—*concluded.*

Tananarive Observatory, 1920.—Two stations, designated *A* and *B*, were occupied. *A* is the pier of absolute house of Tananarive Observatory on Ambohidempona Hill about 3 kilometers east of Tananarive; because of local disturbance care was used to mount instruments at same height as the Observatory instruments when used. True bearings: south tower of Anglican cathedral, 89° 47′.7; summit of Mount Ambohimalaza as supplied by Father Colin, director of the Observatory, distant 42 kilometers, 96° 45′.6.

Station *B* is 10.62 meters south 96° 45′.6 west of station *A* in the line to summit of Mt. Ambohimalaza.

Tongobory, 1920.—Near center of public grounds, west of administrator's residence, 57.65 meters north of north corner of post-office, 15.2 meters north of center of path; marked by a cross in top of limestone block 20 by 25 by 40 centimeters, projecting slightly above surface of ground. True bearings: end of limestone range, 4 kilometers, 258° 28′.1; northeast gable end of roof of prison, 70 meters, 302° 15′.4; bottom of outer edge of northeast pillar of hospital, 80 meters, 327° 41′.0; near corner of post-office, 344° 56′.1.

Tulear, 1920, 1921.—Two stations were occupied. Station *A* is on sea-front, about 200 meters northwest of post-office, between sea-wall and Rue des Quais, 7 meters from sea-wall at point where wall makes an angle, 38.37 meters from lamp-standard on sea-front opposite end of Rue de France, and 49.55 meters from lamp-standard on sea-front to northwest; marked by a hole in top of block of concrete, whose upper surface is 12 by 12 centimeters, projecting 13 centimeters above ground. True bearings: lamp-standard, 144° 24′.4; church spire, 400 meters, 304° 15′.8; lightning-conductor on roof of administrator's residence, 322° 46′.6; northwest corner of warehouse, 200 meters, 335° 09′.5; lamp-standard on sea front, 340° 09′.7; lamp-standard opposite west end of Rue de France, 351° 02′.5.

Station *B* is about 30 meters southeast of French observation point of 1907, on beach just above high-water, at foot of sand-dune, about 230 meters along beach southeast of jetty, and 170 paces southwest of nearest customs shed. True bearings: navigation mark on north side of harbor, 3 kilometers, 95° 58′.2; southwest corner of south customs shed, 139° 51′.4; near gable end of garrison commandant's residence, 120 meters, 174° 17′.6; navigation mark, 1 kilometer, 336° 49′.0.

Zazafotsy, 1920.—In northeast corner of rest-house compound, at south end of village, 23.00 meters and 28.30 meters northeast of northeast and southeast corners of rest-house, respectively, and 16.70 meters southwest of tree near northeast corner of compound. True bearings: prominent tree, 2 kilometers, 22° 25′.9; bottom of cliff, 2 kilometers, 50° 43′.9; southeast corner of rest-house, 59° 45′.4.

ISLANDS, PACIFIC OCEAN.

BISMARCK ARCHIPELAGO.

Rabaul, New Britain, 1915.—On open grassy land facing bay, about one-third mile (0.5 km.) south of large N. D. L. jetty, about 290 feet (88 meters) west of pathway running nearly parallel to shore, and about 145 feet (44 meters) from high-water mark; marked by a wooden peg 1.5 by 1.5 inches (4 by 4 cm.), left 1 inch (3 cm.) above surface. True bearings: conspicuous crag on right side of Beehive Rock, about 1 mile (1.6 km.), 27° 49′.8; near gable end of large boat-shed across harbor, about 1.5 miles (2.4 km.),

ISLANDS, PACIFIC OCEAN.

BISMARCK ARCHIPELAGO—*concluded.*

Rabaul, New Britain, 1915—continued.
108° 55′.9; bottom of flagpole at end of large jetty, about half mile (0.8 km.), 147° 57′.2; near gable end of near tin house, about 360 feet (110 meters), 208° 02′.3.

EASTER ISLAND.

Cook Bay, Easter Island, 1916.—Near shore of Cook Bay, Easter Island, on first small point south-southwest of boat landing, on fairly level ground, about 15 feet (5 meters) above sea-level, at a point in line between two beacons, 137.0 feet (41.76 meters) southeast of one, a barrel beacon set on a rough rock and cement pyramid about 8 feet (2.4 meters) high, with an iron rod and shield projecting upward from middle, and 162.7 feet (49.59 meters) northwest of the other beacon, a triangular shield with black center, mounted on a heavy iron rod set in a concrete block, adjacent to and outside of a high stone fence; marked by a block of concrete and cement work, about 14 inches (36 cm.) square, set about 2 feet (0.6 meter) into ground and projecting about 2.5 inches (6 cm.) above ground, with top surface marked C. I. W., 1916. True bearings: barrel beacon, 142° 17′.6; landing beacon, 238 paces, 209° 19′.1; plaza flagstaff, 268° 06′.0; triangular beacon, 322° 20′.3.

ELLICE ISLANDS.

De Peyster's Island.—See Nukufetau.

Egg or Sutherland Island.—See Nui Island.

Ellice Atoll.—See Funafuti Island.

Funafuti Island, 1915.—Two stations, designated *A* and *B*, were occupied on main island of Funafuti Atoll. Station *A* is southeast of beach, 120 feet (36.6 meters) north of north corner of wire fence surrounding residency, and 21 feet (6.4 meters) northwest of nearest point of path leading from residency to mission house and village; marked by wooden stake projecting 6 inches (15 cm.) above ground. True bearing: northwest extremity of Meulitefala Island, 163° 09′.7.

Station *B* is about one-fourth mile (0.4 km.) northeast of station *A*, 36 feet (11.0 meters) northwest of nearest point of path, about 55 feet (16.8 meters) southeast of nearest point of beach, 81 feet (24.7 meters) north-northeast of north corner of stone square inclosing graves, and 120 feet (36.6 meters) southwest of wire fence around Mr. O'Brien's house; marked by wooden stake projecting 4 inches (10 cm.) above ground. True bearings: top of crane-mast on Allen's wharf, about 700 feet (213 meters), 51° 41′.4; northwest extremity of Meulitefala Island, 161° 43′.4; near gable end of O'Brien's house, 218° 01′.8.

Hudson Island.—See Nanomana Island.

Mitchell Atoll.—See Nukulailai Island.

Nanomana Island, 1915.—At a point on foreshore near landing place on west coast of island, about 30 feet (9.1 meters) east of edge of sandy beach, and about 95 feet (29 meters) from mean high-water mark; marked by peg driven just below ground. True bearings: top of post on sandy beach, three-fourths mile (1.2 km.), 193° 12′.8; right edge of near corner post of veranda of pastor's house, about 350 feet (107 meters), 218° 23′.2; northwest corner of roof of church, about 360 feet (110 meters), 233° 07′.6; near gable end of church, about 300 feet (91 meters), 248° 49′.4; southeast corner of base of flagstaff, 121 feet (36.9 meters), 261° 27′.5.

ISLANDS, PACIFIC OCEAN.

ELLICE ISLANDS—*continued.*

Nanomea Island, 1915.—On open ground in front of group of huts at landing place on west side of island, 34.3 feet (10.45 meters) southwest from west corner of third hut from corner nearest flagstaff, 43.5 feet (13.26 meters) west from south corner of same hut and in line with its northwest side, 43.8 feet (13.35 meters) and 62 feet (18.9 meters) nearly south from south and west corners of fourth hut from flagstaff; marked by wooden peg driven flush with ground. True bearings: east corner of most distant hut to northeast, 228 feet (69.5 meters), 223° 38′.0; south corner of church at base, about 380 feet (116 meters), 294° 18′.3; north corner of base of flagstaff at ground, 174 feet (53.0 meters), 313° 32′.8.

Niutao Island, 1915.—On southwest coast on sandy beach in front of group of huts near church, in line with northwest side of hut about 50 feet (15 meters) southeast of pastor's house, 79 feet (24.1 meters) southwest of west corner of same hut, and 89 feet (27.1 meters), 71 feet (21.6 meters), and 110 feet (33.5 meters) respectively from east, south, and west corners of pastor's house. True bearings: top of flagstaff, 156 feet (47.5 meters) to base, 145° 53′.5; east corner of pastor's house, 194° 56′.4; west corner of near hut, 228° 27′.7; north corner of boat-shed, about 1 mile (1.6 km.) along beach, 312° 40′.8.

Nui Island, 1915.—Near landing place on west shore of island, about 100 feet (30 meters) north of stone base of white flagstaff, 74 feet (22.6 meters) south of black flagpole, 62 feet (18.9 meters) west-southwest from northwest corner of a hut, 69 feet (21.0 meters) northwest from southwest corner of same hut, and 142 feet (43.3 meters) northwest of northeast corner of meeting-house southeast of white flagstaff; marked by wooden peg driven just below ground. True bearings: corner of prominent rock on reef, half mile (0.8 km.), 88° 46′.4; left edge of black flagpole at base, 180° 38′.4; northeast corner of meeting-house, 325° 17′.7; top left corner of base of white flagstaff, 101 feet (30.8 meters), 339° 26′.4.

Nukufetau Island, 1915.—On sandy beach in front of village at north end of island, in line with northwest side of stone base of flagstaff, 125 feet (38.1 meters) northeast of its north corner, 185 feet (56.4 meters) east-northeast from north corner of police hut, 152 feet (46.3 meters) east-southeast from east corner of the hut immediately north of police hut, and 183 feet (55.8 meters) from north corner of hut southeast of police hut. True bearings: top right corner of base of flagstaff, 125 feet (38.1 meters), 48° 32′.5; lone palm tree on reef across lagoon, about 7 miles (11 km.), 240° 23′.9.

Nukulailai, 1915.—On northwest shore of island, 18.5 feet (5.64 meters) east of edge of 3-foot (91-cm.) bank forming boundary between foreshore and beach, 109 feet (33.2 meters) north of northwest corner of stone base of flagstaff, and about 450 feet (137 meters) west of pastor's house; marked by round post 3 inches (7.6 cm.) in diameter projecting 6 inches (15 cm.) above ground. Approximate true bearings: top right corner of base of flagstaff, 109 feet (33.2 meters), 3°; near corner of pastor's house, 3 feet (91 cm.) above ground, 450 feet (137 meters), 272°.

St. Augustine Atoll.—See Nanomea Island.

Speiden or Lynx Island.—See Niutao Island.

Tracy Island.—See Vaitupu Island.

Vaitupu Island, 1915.—On border between sandy beach and foreshore, about 600 feet (183 meters) south of

ISLANDS, PACIFIC OCEAN.

ELLICE ISLANDS—*concluded.*

Vaitupu Island, 1915—continued. flagstaff at landing place on west side of island, about 100 feet (30 meters) west of roughly defined path leading from landing place to south side of island, and about 350 feet (107 meters) southwest of Chinaman's store; marked by stake projecting 4 inches (10 cm.) above ground. True bearings: prominent rock on reef, about 2 miles (3 km.), 150° 07′.7; near gable end of Chinaman's store, 197° 34′.6.

FIJI ISLANDS.

Suva, Dr. Klotz's Station, Viti Levu Island, 1915.—Close reoccupation of Dr. Klotz's station of 1903 and C. I. W. station of 1906, though original marking-post had been replaced by earthenware drain-pipe 15 inches (38 cm.) in diameter set by the Survey Department, 52 feet (15.8 meters) from town hall. True bearings: left edge of Joske's Thumb, about 6 miles (10 km.), 114° 34′.8; beacon on Lami River reef, about 1¼ miles (2 km.), 138° 22′.0.

GILBERT ISLANDS.

Apaiang Island, 1915.—About 100 feet (30 meters) southwest from high-water mark, about 30 feet (9 meters) southeast of path leading from mission house to landing place on west side of island, and about 360 feet (110 meters) northeast of missionary's house; marked by peg set just below ground. True bearing: left edge near roof of missionary's house, 45° 36′.8.

Arorai Island, 1915.—On west shore of island, 128 feet (39.0 meters) southwest of nearest point of wide avenue running to south end of island, 172 feet (52.4 meters) northeast of well inclosed by circular wall near landing place, 46 feet (14.0 meters) west of west corner of second hut north of church, and 41 feet (12.5 meters) southwest of south corner of third hut in same row; marked by peg set just below ground. True bearings: right edge of wall around well, 42° 14′.6; north corner of church at base, 260 feet (79.2 meters), 311° 14′.2.

Byron Island.—See Nukunau Island.

Charlotte Island.—See Apaiang Island.

Clerk Atoll.—See Onoatoa Island.

Drummond Atoll.—See Tapeteuea Island.

Francis Atoll.—See Peru Island.

Hurd Island.—See Arorai Island.

Maraki Island, 1915.—About 270 feet (82 meters) southeast of flagpole at landing place on west side of island, 10 feet (3.0 meters) northwest of drystone dike built parallel to shore, 12.5 feet (3.81 meters) north-northwest of north side of gap in dike, and 6 feet (1.8 meters) northwest of nearest point of large breadfruit tree; marked by peg set just below ground. True bearings: near post of native hut on south side of road, about 30 feet (9.1 meters), 51° 58′; left edge of flagpole at base, about 270 feet (82 meters), 119° 36′.3; near post of native hut southeast of dike, about 27 feet (8 meters), 314° 06′.

Matthew Island.—See Maraki Island.

Nonuti Atoll, 1915.—About 600 feet (183 meters) southwest of northern extremity of island in edge of coco-palm grove, about 150 feet (46 meters) from high-water mark, about 400 feet (122 meters) northeast of nearest hut in Temotu village, near canoe landing; marked by stake projecting 2 inches (5 cm.) above ground. True bearings: ruin on island to the southwest, 1,000 feet (305 meters), 53° 27′; prominent tree on Nonuti Island, about 3 miles (4.8 km.), 191° 08′.4.

ISLANDS, PACIFIC OCEAN.

GILBERT ISLANDS—*continued.*

Nukunau Island, 1915.—In partial clearing in bush northeast of landing place at Ronata, on west side of island, about 8 feet (2.4 meters) south of roughly defined path running northeastward from pastor's house, and about 650 feet (198 meters) northeast of road skirting coast; marked by stake projecting 6 inches (15 cm.) above ground. True bearing: south gable end of roof of Smith's store, about 800 feet (244 meters), 40° 14′.3.

Ocean Island, 1915.—On government ground in front of residence assigned to government accountant, 16 feet (4.9 meters) north of path from residency to phosphate works, and 153.5 feet (46.8 meters) northwest of near end of bridge spanning railroad cut; marked by post projecting slightly above ground. True bearings: top center of roof of accountant's house, about 250 feet (76 meters), 162° 34′.3; near gable end of iron shed on east side of railway, about one-fourth mile (0.4 km.), 268° 27′.9; near corner of right side of bridge, about 180 feet (54.9 meters), 308° 15′.7.

Onoatoa Island, 1915.—On northern island of Onoatoa Atoll, at land edge of sandy beach near landing place at Buariki village, 102 feet (31.1 meters) west of main road running lengthwise of island, and about 1,000 feet (305 meters) northwest of pastor's house; marked by wooden post 3 by 3 inches (7.6 by 7.6 cm.) projecting 6 inches (15 cm.) above ground. True bearing: beacon on Temuah Island, about 2¾ miles (4.4 km.), 107° 12′.2.

Paanapa Island.—See Ocean Island.

Peru Island, 1915.—On ground covered with thick growth of coconut and palm trees, 50 feet (15.2 meters) south of road running through grounds of Rongorongo Training College of London Missionary Society from east side of island to main entrance at jetty, measured from point on road 247 feet (75.3 meters) northeast of point in line with northeast side of Mr. Arnold's house; marked by wooden stake projecting 9 inches (23 cm.) above ground. True bearing: fourth veranda post from east corner of Mr. Arnold's house, about 300 feet (91 meters), 88° 59′.4.

Ronata, 1915.—See Nukunau Island.

Rotcher Island.—See Tamana Island.

Sydenham Atoll.—See Nonuti Atoll.

Tamana Island, 1915.—On southwest shore of island, in road leading southeast from pastor's house, 6 inches (15 cm.) from northeast boundary of road, 15.5 feet (4.7 meters) south-southeast of breadfruit tree, and 495 feet (150.9 meters) southeast of pastor's house. True bearing: near post of veranda in front of pastor's house, 135° 52′.4.

Tapeteuea Island, 1915.—About 500 feet (152 meters) northwest of landing place and mission church at Utiroa village, in line with seaward edge of most southerly projection of second canoe-shed from mission church, 16 feet (4.9 meters) northwest of west corner of projection, and 30 feet (9.1 meters) from seaward edge of westerly projection of shed; marked by peg set just below ground. True bearing: beacon on reef, about 2½ miles (4 km.), 29° 27′.8.

Tarawa Island, 1915.—On a triangular open space east of Residency containing cricket-pitch, in line with southeast edge of pitch, 69 feet (21.0 meters) southwest of south corner of pitch, 35 feet (10.7 meters) northwest of nearest point of road leading to jetty, 71 feet (21.6 meters) and 98 feet (29.9 meters), respectively, from eastern and western stump-holes of cricket-pitch; marked by peg set just below ground. True bearings:

ISLANDS, PACIFIC OCEAN.

GILBERT ISLANDS—*concluded.*

Tarawa Island, 1915—continued.
western stump-holes, 179° 38′; left beacon marking entrance to boat passage, half mile (0.8 km.), 182° 27′.4; right beacon marking entrance to boat passage, half mile (0.8 km.), 186° 19′.2; left edge of government boat-shed, 250 feet (76.2 meters), 211° 01′.8; eastern stump-holes, 221° 59′; right edge of fence around government boat-shed, 290 feet (88.4 meters), 223° 46′.7.

HAWAIIAN ISLANDS.

Sisal, Honolulu Magnetic Observatory, Oahu Island, 1915.—Observations were made on *Pier A* in absolute house, Honolulu Magnetic Observatory, of United States Coast and Geodetic Survey.

Station *A* is outside observatory inclosure, 18.46 meters north of *Pier A* in line with north meridian mark which is distant 2,800 feet (853 meters), on level coral plain 6.4 meters north of stone wall surrounding inclosure; marked by wooden peg with copper tack at precise point. True bearings: trigonometric staff on mountain, 148° 30′.5; V-cut in mountain, 160° 02′.3; north meridian stone, 180° 00′.0.

Station *B* is 2.8 meters north of south stone wall of observatory inclosure measured from a mark chiseled in wall, 12.50 meters southwest of southwest corner of absolute house, 18.01 meters east of southeast corner vestibule of variation observatory, and 15.70 meters southeast of near corner of thermometer shelter; marked by copper nails in top of hardwood peg. True bearings: southeast corner vestibule variation observatory, 88° 48′.1; trigonometric staff on mountain, 148° 39′.5; V-cut in mountain, 160° 07′.9; right corner office building, 202° 12′.5; southwest corner absolute house, 212° 42′.6; Mount Tantalus, 265° 46′.8.

LORD HOWE ISLAND.

Lord Howe Island, 1915.—On north shore of Lord Howe Island, about midway between landing place and two thatched sheds on Ned's Beach, about 240 feet (73 meters) east from larger shed, and 120 feet (36.6 meters) south of nearest point of beach. True bearing: highest point of Admiralty Islet (as given by British Admiralty chart), 1.3 miles (2.1 km.), 180° 15′.

MARIANAS.

Guam, Sumay, 1916.—On hill west of Sumay, Port Apra, on sloping grounds of Commercial Pacific Cable Company, about midway between north end of cement tennis-court and north end of bungalow B, in line between right heavy edge of wireless mast near ground and point 1 foot (30 cm.) north of eaves of bungalow B. Station *A* is 42.0 feet (12.80 meters) northwest of a large tree, 164.3 feet (50.08 meters) northeast of southeast cement porch-pier of bungalow B, 182.6 feet (55.66 meters) southeast of northeast cement porch-pier of bungalow A, 463.7 feet (141.34 meters) southwest of south ventilator of superintendent's house; marked by round instrument peg. True bearings: left edge of house D, 20° 36′.7; left edge of bungalow B, 65° 40′.4; south ventilator of superintendent's house, 233° 44′.6; wireless mast, 260° 02′.3; tip of south ventilator of mess house, 280° 36′.7.

Station *B* is 91.6 feet (28.22 meters) east of *A* in line with wireless mast, 80.1 feet northeast of tree, 99.7 feet (30.39 meters) west of near corner of tennis-court; marked by round stake. True bearings: left edge of bungalow D, 32° 03′.3; wireless mast, 260° 36′.7; south ventilator of mess house, 286° 42′.5.

Guam, Cabras Island, 1916.—Close reoccupation of C. I. W. station of 1906, Port Apra, on northern shore of

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MARIANAS—*concluded.*

Guam, Cabras Island, 1916—continued.
harbor, left of channel leading from main harbor to town of Piti, Guam, near water edge and south of coral reef ledge 25 to 50 feet (8 to 15 meters) high extending along northern shore-line, at a point 60 feet (18.3 meters) west of southwest corner of coal-bunkers, 63 feet (19.2 meters) south of front edge of magazine-house, and 30 feet (9.1 meters) north of low-water edge. True bearings: tip of wind-mill tower at Sumay, 40° 11′.7; right edge of bluff at Oroté Point, 74° 20′.

Guam, Oroté Point, 1916.—Close reoccupation of C. I. W. station of 1906, at entrance of Port Apra, just up over break of beach line on first sandy beach encountered on coming into harbor after passing Oroté Island, 85 feet (25.9 meters) east of a 3-inch field gun, and about 150 feet (46 meters) south of coral-reef edge. True bearings: flagpole at Piti, 257° 24′.0; right edge of wireless mast across harbor, back of town of Agaña, about 8 miles (13 km.), 266° 12′.4.

NEW CALEDONIA (INCLUDING LOYALTY ISLANDS).

Bourail, 1915.—On north shore of Bourail River, near its mouth, 121 feet (36.9 meters) north-northeast from beacon-shed with V-shaped wind-shields, and about 270 feet (82 meters) northwest of small stone jetty; marked by peg driven flush with ground. True bearings: top of near beacon, 121 feet (36.9 meters), 22° 22′.6; top of lighthouse across bay, three-fourths mile (1.2 km.), 138° 43′.6; right gable end of Porte de Mer, 300 feet (91 meters), 252° 56′.5; right edge of post on jetty at ground, 270 feet (82 meters), 301° 06′.5.

Keppanie, Lifu Island, 1915.—See Lifu Island.

Lifu Island (*Keppanie*), 1915.—About 130 feet (39.6 meters) north of landing place in northeast corner of Sandal Bay, on west coast of Lifu Island, on small mound 26 feet (7.9 meters) northeast of shore of small lagoon forming natural landing harbor. True bearings: left edge of Protestant church across bay, 10 miles (16 km.), 11° 09′.1; statue on Mekitapune Church, 3½ miles (5.6 km.), 76° 34′.9; spike on left gable of Eacho Church, 1½ miles (2.4 km.), 102° 56′.6; top of flagpole in front of Residency, 800 feet (244 meters), 148° 21′.9; top of right gate-post in front of missionary's house, 450 feet (137 meters), 214° 53′.1; right gable end of Mr. Wright's house, 900 feet (274 meters), 265° 10′.2.

Observations for diurnal variation in declination were made at a secondary station 30 feet (9 meters) due north of main station, which could not be reoccupied on account of building operations, True bearing: statue on Mekitapune Church, about 3½ miles (5.6 km.), 76° 21′.2.

Maré Island (*Tatyn*), 1915.—On flat open space used by natives as a playground, about half mile (0.8 km) along road running north from landing place in Tatyn Bay, on west coast of Maré Island, almost in line with two coconut trees to the north-northeast, distant 27 and 51 feet (8.2 and 15.5 meters) respectively, 52 feet (15.8 meters) east-northeast of nearest point of bay, and about 210 feet (64 meters) west-northwest from southwest corner of thatched house; marked by peg driven flush with ground. True bearings: left edge of white house across bay, 5 miles (8.9 km.), 5° 00′.6; extreme edge of cliff at south end of bay, 8 miles (12.8 km.), 32° 09′.0; extreme edge of cliff at north end of bay, 3½ miles (5.6 km.), 119° 05′.9; right edge of white building near ground, about 300 feet (91 meters), 224° 08′.9; top of flagpole in front of Residency, about 1 mile (1.6 km.), 352° 01′.6.

ISLANDS, PACIFIC OCEAN.

NEW CALEDONIA (INCLUDING LOYALTY ISLANDS)—*concluded.*

Noumea, 1915.—In valley east of zigzag road leading from town up to signal station, 132 feet (40.2 meters) east of lamp-post standing in road about 200 feet (61 meters) above its last sharp turn; marked by wooden post projecting about 3 inches (8 cm.) above ground and covered with cairn of stones. True bearings: top of left beacon-pole on hill, 1,000 feet (305 meters), 19° 14′.7; end of left cross-piece on lamp-post, 132 feet (40.2 meters), 75° 51′.1; top of flagpole at signal station, three-fourths mile (1.2 km.), 173° 47′.8; near gable end of physician's house on hill, 1½ miles (2.4 km.), 308° 15′.4; spike on center of front of military barracks, 1½ miles (2.4 km.), 329° 02′.2.

Paagoumene, 1915.—On plain west of winding sheds and buildings of Chrome Mining Company, in line with northwest fence of cemetery, 121.7 feet (37.10 meters) northeast of north corner post of cemetery fence, and 176 feet (53.6 meters) north-northeast of east corner post of cemetery fence; marked by post projecting about 3 inches (8 cm.) above ground and covered with cairn of stones. True bearings: wooden cross on grave, 210 feet (64.0 meters), 32° 28′.8; top of beacon pole on hill, half mile (0.8 km.), 44° 41′.6; right edge of window on east side of hut, 300 feet (91 meters), 167° 00′.1; right edge near ground of right gate-post on hill, 900 feet (274 meters), 263° 24′.6.

Tatyn, Maré Island, 1915.—See Maré Island.

Uvea Island (Uvea), 1915.—Towards south end of west coast of island, in partial clearing in front of residence of Protestant missionary, 110 feet (33.5 meters) southeast of remains of wooden fence around mission grounds, 207 feet (63.1 meters) northeast of corner of same fence, 178 feet (54.3 meters) north-northeast of bell post near Protestant church, 182.5 feet (55.62 meters) northwest from nearest corner of small wooden fence surrounding missionary's residence, and 37 feet (11.3 meters) southeast of a coconut tree; marked by peg driven flush with ground. True bearings: right edge of bell-post near ground, 178 feet (54.3 meters), 27° 23′.7; top right corner of window in white hut, about 900 feet (274 meters), 210° 18′.7; post at northwest corner of fence around missionary's residence, 182.5 feet (55.62 meters), 320° 27′.7.

Walpole Island, 1915.—Near south end of large bay on west side of island, about 600 feet (183 meters) along rocky limestone ledge northward from landing place.

NEW GUINEA (INCLUDING LOUISIADE AND D'ENTRECASTEAUX ISLANDS).

Bramble Cay, 1915.—See Bramble Cay, Australia.

Buna Bay 1915.—On foreshore, about 900 feet (274 meters) northeast of jetty, 135 feet (41.1 meters) northwest of near edge of path from jetty to residency running nearly parallel to shore, and about 90 feet (27 meters) from high-water mark; marked by a wooden peg 1.5 by 1.5 inches (4 by 4 cm.), left level with surface. True bearings: spike on porch of Mr. Oates's house, about 450 feet (137 meters), 21° 41′.7; beacon on sand-bank, about 2 miles (3 km.), 154° 49′.2; top of flagpole at residency, 246° 41′.7; near gable end of native quarters, about 360 feet (110 meters), 285° 50′.6.

Cape Nelson, 1915.—At extremity of steep cliff about 500 feet (152 meters) east of jetty, 138 feet (42.1 meters) south-southeast of southwest corner of residency, 75 feet (23 meters) south of base of flagpole in front of residency, about 33 feet (10 meters) southeast of nearest point of zigzag path leading up face of cliff

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NEW GUINEA (INCLUDING LOUISIADE AND D'ENTRECASTEAUX ISLANDS)—*continued.*

Cape, Nelson, 1915—continued.
from jetty to residency, and 5.7 feet (1.74 meters) southwest of a wooden post 4 feet (1 meter) high and about 15 inches (38 cm.) in diameter. True bearings: tower-beacon on hill, about 1 mile (1.6 km.), 70° 42′.7; left gable end of residency, about 145 feet (44 meters), 167° 08′.6; right edge of trader's hut, about 1.5 miles (2.4 km.), 241° 44′.4.

Daru Island, 1915.—On foreshore, west of stone jetty, about 156 feet (48 meters) northwest of residence of Mr. Luff, about 90 feet (27 meters) south-southwest of nearest point of wooden embankment along shore, in a line with remains of a wooden fence about 100 feet (30 meters) long, and 60 feet (18 meters) west of its most westerly post.

Delami Island, 1915.—On flat open ground between beach on north side of island and thick scrub covering center of island, at a point about 75 feet (23 meters) west of path leading from landing place to village, and about 10 feet (3 meters) north of edge of thick scrub. True bearing: prominent tree on near island, about 3 miles (5 km.), 175° 45′.2.

Doini Island, 1915.—On west side of island, on sandy beach, about 700 feet (213 meters) southwest of west corner of copra store shed, and about 900 feet (274 meters) south-southwest of a post about 100 feet (30 meters) northwest of north corner of copra-shed.

Entrance Island, 1915.—Near northeast corner of island, near center of sandy beach. True bearing: gap in trees on left of island to southeast, about 7 miles (11 km.), 321° 34′.2.

Gawa Island, Marshall Bennet Islands, 1915.—On northwest shore of island, on foreshore, at landing place near anchorage between Tree Rock Point and Suimgwai Point, about 8 feet (2 meters) north of most northerly of two large canoe-sheds, and about 8 feet (2 meters) from high-water mark.

Ipoteto Island, 1915.—At southeastern extremity of island, on a sandy spur, 9 feet (3 meters) from each of two small trees which are about 6 feet (2 meters) apart, and about 16 feet (5 meters) from high-water mark at southeastern extremity of island.

Kapakapa, 1915.—Near shore, among coconut trees, 273 feet (83.2 meters) northwest of west corner of mission church and in line with its front, and about 70 feet (21 meters) from high-water mark; marked by a wooden peg.

Kiagouam Island, D'Entrecasteaux Group, 1915.—Near center of a sandy spit at southeastern end of island, about 35 feet (11 meters) from high-water mark on west side of island, about 45 feet (14 meters) from high-water mark on east side of island, and about 100 feet (30 meters) from southeast extremity of island. True bearings: tree on Poebara Island, 1.5 miles (2.4 km.), 58° 35′.9; tree near summit of Dawson Island, 2 miles (3 km.), 318° 41′.8.

Kiriwina Island, Trobriand Islands, 1915.—On south shore of northern portion of island, in center of small sandy beach, northwest of anchorage on west side of island, 23.5 feet (7.16 meters) west of a large bread-fruit tree, and about 18 feet (5 meters) from high-water mark.

Kwato Island, 1915.—On south side of island, at east end of flat, northeast of landing jetty and boat-shed, in line with southern edge of veranda around most eastern wooden native hut and 245 feet (74.7 meters) east-northeast of its southeast corner, and about 60

ISLANDS, PACIFIC OCEAN.

NEW GUINEA (INCLUDING LOUISIADE AND D'ENTRECASTEAUX ISLANDS)—*continued.*

Kwato Island, 1915—continued.
feet (18 meters) from high-water mark; marked by a peg 1.5 by 1.5 inches (4 by 4 cm.), left level with surface. True bearings: left edge of flagpole by jetty, seen over boat-shed, about 550 feet (168 meters), 50° 15′.4; left edge of white fence by sawmill, about 900 feet (274 meters), 73° 10′.6; beacon-post off east of Rogea Island, about 2 miles (3.2 km.), 308° 25′.4.

Mambare, 1915.—On foreshore, about 200 feet (61 meters) southwest of small landing jetty near government hut, 15 feet (4.6 meters) southeast of beach and about the same distance from dry bed of creek lying parallel to southeast; marked by a peg. True bearings: extremity of Warsong Point, 2.5 miles (4 km.), 147° 13′.6; bottom of channel-marker off Dead Mangrove Point, 2 miles (3 km.), 200° 07′.4; northeast corner post of government hut, at ground, 240 feet (73 meters), 269° 49′.0.

Misima Island, 1915.—Along foreshore southeast of jetty, about 500 feet (152 meters) southeast of shore end of jetty, about 450 feet (137 meters) southeast of east corner of shed near jetty, used for storing miners' implements, and about 9 feet (3 meters) from high-water mark; marked by a wooden peg. True bearings: hurricane lamp by east corner of shed near jetty, 159° 42′.4; prominent tree on reef in center of harbor, 253° 51′.2.

Panasesa Island, Conflict Islands, 1915.—On north coast of island, on path leading from landing place near anchorage up to residence of Mr. Vernier, in center of path at point where it turns toward south, 132 feet (40.2 meters) from high-water mark. True bearing: prominent tree on Gabuga Island, about 2 miles (3 km.), 226° 32′.6.

Port Moresby, 1915.—Two stations, designated *A* and *B*, were occupied. *A* is on north face of steep hill rising from shore, about half mile (0.8 km.) southwest of main jetty, at a point about 700 feet (213 meters) west of land end of jetty, 40 feet (12.2 meters) north of nearest point of path running west from town to government residential quarters along face of hill, and about 30 feet (9 meters) from high-water mark; marked by a wooden peg. True bearings: top of roof of government quarters, 900 feet (274 meters), 71° 19′.8; red beacon on reef, one-third mile (0.5 km.), 139° 55′.9; right edge of leading mark across harbor, 2 miles (3 km.), 165° 48′.4; right edge of green lamp on jetty, 900 feet (274 meters), 201° 43′.1; conspicuous tree near summit of Mount Pullen, 2.5 miles (4 km.), 209° 24′.5; gable end of cottage, 750 feet (229 meters), 290° 27′.7.

B is in western corner of police parade-ground, 105 feet (32.0 meters) east of west corner post, and 91 feet (27.7 meters) northeast of southwest fence, measured past small tree which is 25 feet (7.6 meters) from fence; marked by a wooden peg. True bearings: near gable end of boat-shed across bay, 2 miles (3 km.), 94° 59′.2; top of lower section of flagpole at government offices, half mile (0.8 km.), 189° 24′.6; left gable end of police barracks, 300 feet (91 meters), 242° 50′.3; top center of left wireless pole, half mile (0.8 km.), 339° 33′.3.

Samarai, 1915.—Two stations, designated *A* and *B*, were occupied. Station *A* is near southeast end of recreation-reserve, forming apex of equilateral triangle of which two small breadfruit trees, 32 feet (9.8 meters) apart, form base; marked by a peg 1.5 by 1.5 inches (4 by 4 cm.), left level with surface. True bearings: right gable end of police quarters, 300 feet (91 meters), 10° 33′.9; left corner of roof of pavilion, 220 feet (67 meters), 93° 19′.7; near corner of Robinson's monument, taken 8 feet (2.4 meters) from ground, 450 feet (137 meters), 162° 13′.0; near gable end of house, 210 feet (64 meters), 263° 30′.8.

Station *B* is on northeast side of island, about one-fourth mile (0.4 km.) along path running from jetty southeastward around edge of island. True bearing: left corner of house on end of jetty, 150° 24′.9.

Suau Harbor, 1915.—In southeast corner of harbor, near center of sandy beach below high ground covered with coconut trees and scrub, about 18 feet (5 meters) from high-water mark. True bearing: tree on extremity of cape across harbor, 74° 10′.0.

Woodlark Island, 1915.—About half mile (0.8 km.) north-northeast of landing place at Bonagai, near summit of a steep hill, 49 feet (14.9 meters) southeast of near edge of path leading down hill to jetty, and 133 feet (40.5 meters) southwest of west corner post of foundations of old custom-house; marked by a wooden peg 1.5 by 1.5 inches (4 by 4 cm.), left level with surface. True bearings: left beacon in south channel, 1.5 miles (2.4 km.), 93° 20′.1; top of left wireless pole, 2 miles (3 km.), 165° 55′.4; top of right wireless pole, 171° 21′.0; left top corner of west corner foundation post of old custom-house, 212° 50′.7; chimney-stack on Mr. Craig's house, half mile (0.8 km.), 340° 27′.9.

Yule Island (*Roro or Lolo Island*), 1915.—Two stations, designated *A* and *B*, were occupied. Station *A* is on foot-path close to shore, about 600 feet (183 meters) north of shore end of jetty. True bearing: near gable end of shed by jetty, 345° 33′.8.

Station *B* is on open flat space about one-fourth mile (0.4 km.) north of station *A*, and about 60 feet (18 meters) northwest of nearest point of path running along close to shore; marked by a peg 1.5 by 1.5 inches (4 by 4 cm.) left 1 inch (3 cm.) above surface. True bearing: right top of beacon at end of jetty, 347° 44′.7.

NEW HEBRIDES.

Aoba Island (*Ndui-Ndui*), 1915.—In a small clearing on north side of path leading from shore southeast to house of Mr. Waters, the Protestant missionary, 15 feet (4.6 meters) from nearest point of path, 46 feet (14.0 meters) east of coconut tree at west end of clearing, and 73 feet (22.2 meters) northwest of tree at east end of clearing; marked by peg driven just below ground. True bearing: near gable end of Mr. Waters's house, about 600 feet (183 meters), 290° 26′.8.

Banks Islands, 1915.—See Kakea.

Diamond Bay, Epi Island, 1915.—On west side of path running from point on beach of Diamond Bay about 600 feet (183 meters) west of jetty northward to M. Naturel's house, 9 feet (2.7 meters) southwest of large dead tree on east side of path, and about 90 feet (27 meters) north of flagpole at south end of path.

Duin-dui, Aoba Island.—See Aoba Island, Ndui-ndui.

Epi Island, 1915.—See Diamond Bay and Ngala.

Fila, Sandwich Island, 1915.—Near top of hill at rear of post-office building, 111 feet (33.8 meters) north-northeast of northwest corner of wire fence surrounding Protestant church and British Residency offices,

ISLANDS, PACIFIC OCEAN.

NEW HEBRIDES—*continued.*

Fila, Sandwich Island, 1915—continued.
93 feet (28.3 meters) north of nearest point of same fence, and 35 feet (10.7 meters) north of a tree; marked by peg driven just below ground. True bearings: ornament on front gable of Protestant church, 600 feet (183 meters), 1° 43′.6; top left corner of bottom section of flagpole at British Residency, 1½ miles (2.4 kilometers), 52° 48′.2; extreme edge of Devil's Point, 10 miles (16 km.), 87° 56′.2; spike on top of wireless house, 500 feet (152 meters), 164° 54′.5.

Kakea Island, Banks Islands, 1915.—In scrub east of houses and copra-sheds on northwest shore of Kakea Island, about 360 feet (110 meters) east-northeast of easternmost hut, and about 300 feet (91 meters) southeast of nearest point of beach. True bearing: bottom left corner of window in easternmost hut, about 360 feet (110 meters), 70° 42′.5.

Leper's Island.—See Aoba Island.

Mallicollo Island (Malekula Island), 1915.—See Port Sandwich, and Tesman Bay.

Ndui-Ndui, Aoba Island, 1915.—See Aoba Island (Ndui-Ndui).

Ngala, Epi Island, 1915.—East of Drummond Bay, southeast of Ariel Point on northeast coast of Epi Island, between rows of coconut trees running eastward from beach of Drummond Bay, about 340 feet (104 meters) east of shore end of coconut grove near copra-shed; marked by peg driven flush with ground. True bearing: right corner of near gable of copra-shed, about 340 feet (104 meters), 94° 33′.5.

Pentecost Island, 1915.—On west coast of island north of Casuarina Point, about 150 feet (46 meters) northeast of path leading from landing place to Mr. Cameron's house, about 100 feet (30 meters) east of high-water mark, and about 30 feet (9 meters) west of edge of scrub. True bearing: extreme end of whale point, 3 miles (4.8 meters), 161° 58′.2.

Port Sandwich, Mallicollo Island, 1915.—On west side of spur of land forming west boundary of harbor of Port Sandwich, at west end of grove of coconut trees running west from abandoned store building, and about 30 feet (9.1 meters) from high-water mark; marked by peg projecting 9 inches (23 cm.) above ground.

Sandwich Island, 1915.—See Fila.

Tangice Island, 1915.—Near northeast corner of island lying in Baldwin Cove, south of Santo Island, about 300 feet (91 meters) due east of largest copra-shed, about 400 feet (122 meters) southeast of landing, and about 200 feet (61 meters) south of nearest point of shore line. True bearing: near gable end of large shed, 300 feet (91 meters), 89° 18′.4.

Tangoa Island, 1915.—On north shore of Tangoa Island, a small island close to south shore of Santo Island in Baldwin Cove, about 400 feet (122 meters) west of jetty, 150 feet (32.0 meters) west of breakwater, 12 feet (3.7 meters) north of a line of trees, and about same distance from high-water mark; marked by peg set just below ground.

Tasariki, Santo Island, 1915.—At edge of bush and beach, about 450 feet (137 meters) east of landing place at Tasariki. True bearing: extreme end of Bumbuari Point, 4 miles (6.4 km.), 152° 09′.6.

Tesman Bay, Mallicollo Island, 1915.—In southeast corner of paddock in front of Mr. Laing's house, 30 feet (9 meters) east of a group of tall bamboo trees, 40 feet (12 meters) north of a clump of coconut trees,

ISLANDS, PACIFIC OCEAN.

NEW HEBRIDES—*concluded.*

Tesman Bay, Mallicollo Island, 1915—continued.
and 160 feet (48.8 meters) southwest of gate in northeast fence of paddock; marked by peg driven just below ground. True bearings: top of right edge of south corner post of paddock, 400 feet (122 meters), 21° 25′.1; top right edge of corner post on hill, 700 feet (213 meters), 167° 40′.2; right edge of gable on copra-shed, 500 feet (152 meters), 278° 45′.4.

NORFOLK ISLAND.

Norfolk Island, 1915.—About 900 feet (274 meters) west of landing rocks in Cascade Bay, on north side of Norfolk Island, about 12 feet (3.7 meters) south of edge of cliff, and 76 feet (23.2 meters) northwest of near beacon; marked by peg driven flush with ground. True bearings: right lamp-support on far beacon, 300 feet (91 meters), 24° 20′.2; projecting rock on headland east of landing, one-fourth mile (0.4 km.), 268° 39′.1; right lamp-support on near beacon, 76 feet (23.2 meters), 302° 36′.1.

SAMOAN ISLANDS.

Apia, Samoa Observatory, Upolu Island, 1915.—Two stations were occupied. The first was north pier, designated *N*, of absolute house of Samoa Geophysical Observatory; this is identical with C. I. W. station of 1911. True bearing: Tuamua Church, as adopted by Observatory, 96° 10′.9. The second was outside *West Pier*, 15 meters south 99° 04′ west from *N*. True bearing: Tuamua Church, 3,250 meters, as adopted by Observatory, 96° 10′.1.

Pago Pago, Tutuila Island, 1916.—Close reoccupation of C. I. W. station of 1911, on parade-ground of Fita-Fita barracks at U. S. naval station in Pago Pago harbor, at a point south of pathway 162.8 feet (49.62 meters) west-southwest of northwest corner of jail connected with barracks, 78.5 feet (23.93 meters) east-northeast of northeast corner of nearest house, 322.0 feet (98.15 meters) southeast of northeast corner of schoolhouse, southeast of and in line with bandstand and flagstaff, 254.2 feet (77.48 meters) south-southwest of concrete astronomical pier about 2 feet (0.6 meter) high and 2 feet (0.6 meter) square, and in line with center of pier and northwest corner of Fita-Fita wash-house; marked by peg left flush with ground. True bearings: lower near corner of nearby house, 65° 05′.6; monument or survey stone in front of Ho Ching's house, 97° 18′.9; astronomical pier, 200° 01′.2; near gable of judge's house, 240° 45′.7; tip of smoke-stack of power-house, one-fourth mile (0.4 km.), 241° 48′.0; bottom of northwest pier of jail, 265° 04′.8.

SOCIETY ISLANDS.

Fort Taravao, Tahiti Island, 1916.—On grounds of Fort Taravao, in front of stone fort, 45 meters northwest of front fence on southeast side of grounds and 8.2 meters northeast of fence on southwest side; marked by round peg 18 inches (46 cm.) long left 2 inches (5 cm.) above surface of ground, a brass tack marking exact point. True bearings: right edge of low house, 29° 19′.1; right gable of cinema, 44° 44′.4; Catholic church steeple, 301° 11′.8.

Mapeti, Tahiti Island, 1916.—Two stations were occupied. *A* is on Mapeti, a coral island, about 190 yards (174 meters) long in northeast and southwest direction, and about 98 yards (90 meters) wide, property of Mr. Raoul, about three-eighths mile (0.6 km.) from town of Mataiea, 31.5 meters west by south of southwest corner of small native house, 13.6 meters northeast

ISLANDS, PACIFIC OCEAN.

SOCIETY ISLANDS—*continued.*

Mapeti, Tahiti Island, 1916—continued.
of northwest corner of southwest end of island, 4.2 meters southeast of high-water mark, and 9.4 meters northwest of nearest tall coconut tree which leans to northwest; marked by round peg 18 inches (46 cm.) long, left 3 inches (8 cm.) above surface of ground. True bearings: gable of large house, 113° 41′.4; right end of concrete breakwater, 157° 28′.0; lamp-post in front of house, 184° 47′.4.

B is on beach at northeast end of island, 3 meters west of high-water mark, 3.1 meters east of edge of grass marking edge of beach, and 11.5 meters south-southeast, 11.1 meters east-southeast and 12.4 meters northeast, respectively, of three coconut trees; marked by round peg 12 inches (30 cm.) long, left 1 inch (3 cm.) above surface of ground. True bearings: lamp-post in front of house, 174° 30′.5; extreme coconut tree on south end of Pururu Island, 263° 57′.3; southernmost end of Tahiti peninsula, 294° 48′.6.

Papeete, Tahiti Island, 1916.—Reoccupation of C. I. W. stations of 1906, 1907 and 1912 within a few meters, in eastern corner of government land used as experimental tract, just south of Botanical Garden, about 107 meters southeast of gardener's house, 56 meters northeast of windmill pump, 47 meters southeast of north fence, 15.2 meters west of east fence, and 9.4 meters north and 6.1 meters south, respectively, of two coconut trees; marked by peg 18 inches (46 cm.) long, left 1 inch (3 cm.) above ground, a copper tack marking exact point. True bearing: middle window of only visible bungalow, 170° 03′.0.

Point Fareute, Tahiti Island, 1916, 1920.—Station of 1920 is close reoccupation of that of 1916, and both are close reoccupations of C. I. W. station of 1906. On coral beach, east of site of old arsenal, 1.2 meters south of high-water line in 1920, about 360 feet (110 meters) north of northeast corner of iron bridge across stream, about 20 meters east of (changeable) mouth of stream, 20.85 meters west of wire fence along roadway, 12.70 meters southwest of coconut tree, and 5.7 meters southwest of small rivulet. True bearings in 1916: east edge of east wireless tower, 47° 43′.2; west edge of west wireless tower, 55° 34′.3. True bearing in 1920: north gable of yellow house, 22° 22′.2.

Poroi's Farm, Taravao, Tahiti Island, 1916.—Station is on Poroi's farm, about 1.5 miles (2.4 km.) from Vieno's farm, on left side of road which branches off at Vieno's farm and leads around western side of peninsula, 35.2 meters southeast of road running in a northeast and southwest direction, and 55 meters southwest of dividing fence separating two farms; marked by square blue-gum peg 12 inches (30 cm.) long, projecting 3 inches (8 cm.) above surface of ground. True bearings: right end of house, 63° 52′.6; tree on distant hill, 126° 42′.4. Tests at three nearby points showed local disturbance.

Pururu, Tahiti Island, 1916.—Two stations were occupied. *A* is on Pururu Island, a coral island belonging to Mr. Sigogne, about 300 yards (274 meters) long in north and south direction and about 150 yards (137 meters) broad at southern end, about 120 yards (110 meters) from town of Vahiria, on cleared spot at southern end of island used as garden and probably containing alluvial soil of volcanic origin, at a point 33 meters west and 69 meters north-northwest, respectively, of high-water mark, and 12.1 meters north of large coconut tree; marked by round peg 24 inches (61 cm.) long, left 3 inches (8 cm.) above surface of ground. True bearings: bridge abutment, 108° 59′.5; last mountain on Tahiti peninsula, 292° 20′.2.

ISLANDS, PACIFIC OCEAN.

SOCIETY ISLANDS—*concluded.*

Pururu, Tahiti Island, 1916—continued.

B is on north end of island, 1.7 meters south and west respectively of high-water mark, and 2.2 meters north-northeast and 7.05 meters north-northwest, respectively, of two coconut trees; marked by round peg 8 inches (20 cm.) long, left 1 inch (3 cm.) above surface of ground. True bearings: left end of Mapeti Island, 75° 03′.7; left end of house, 100° 44′.8; south end of Tahiti peninsula, 299° 59′.3.

Small Coral Island (*Papeete Harbor*), *Tahiti Island*, 1916.—Stations of 1907 and 1912 were impossible of reoccupation, owing to changes in configuration of island. Station occupied was on northern extremity of island, 48.4 meters northwest of northeast corner of hospital, and 3 meters from high-water mark to both east and north; marked by peg 24 inches (61 cm.) long, left 3 inches (8 cm.) above surface of ground. True bearings: cathedral spire, 267° 18′.8; northeast corner of hospital, 314° 06′.7; northwest corner of hospital, 335° 54′.4.

Vieno's Farm, Taravao, Tahiti Island, 1916.—Station is in pasture in front of house on farm of Mr. Vieno, 58 meters north of front fence along main road from Papeete to Taravao, and 63 meters east of westerly side fence dividing pasture from coconut plantation; marked by square red-gum peg 12 inches (30 cm.) long, left 1 inch (3 cm.) above surface of ground. True bearings: right edge of Mr. Vieno's house, 199° 22′.1; right gable of schoolhouse, 331° 39′.7. Tests at two near-by points showed local disturbance.

SOLOMON ISLANDS.

Binskin's Station, 1915.—Near southeast corner of small uncharted island occupied by Mr. Binskin, about half mile east of Bagga Island, 240 feet (73.2 meters) northeast of northeast corner of native quarters, and 9 feet (2.7 meters) west of narrow path running parallel with east coast of island; marked by stake projecting 6 inches (15 cm.) above ground.

Faisi Island, 1915.—On southeast side of path leading from wharf to native quarters, 270 feet (82.3 meters) northeast of near end of store building, and 18 feet (5.5 meters) from near edge of path; marked by peg driven flush with ground. True bearings: near gable end of hut on Poporang Island, 4 miles (6.4 km.), 28° 22′.2; far gable end of jail on Shortland Island, 1.5 miles (2.4 km.), 44° 00′.0; near gable end of store, 56° 27′.8; spike on center front of house on hill, 250 feet (76 meters), 136° 21′.2; northeast corner of roof of native quarters, 800 feet (244 meters), 220° 19′.8; right gable end of native hut on Poporang Island, 1 mile (1.6 km.), 323° 27′.5.

Gizo, 1915.—Two stations, designated *A* and *B*, were occupied on path running eastward from wharf and store towards government buildings. Station *A* is about one-fourth mile (0.4 km.) from wharf, about 600 feet (183 meters) southeast of native quarters; marked by peg set 1 inch (3 cm.) below ground. True bearing: ornament on near gable end of shed on Shelter Island, 2 miles (3.2 km.), 186° 54′.1.

Station *B* is 18 feet (5.5 meters) southeast of station *A*. True bearings: ornament on near gable end of shed on Shelter Island, 2 miles (3.2 km.), 186° 46′.8; cross on porch of church on Latitude Island, 2.5 miles (4 km.), 248° 59′.5; near gable end of shed at government jetty, 1,800 feet (549 meters), 289° 23′.3.

Guadalcanar Island, 1915.—East of fence inclosing residential quarters of Solomon Islands Development Company, in line with front edge of north veranda of

ISLANDS, PACIFIC OCEAN.

SOLOMON ISLANDS—*concluded.*

Guadalcanar Island, 1915—continued.
manager's house, and 108 feet (32.9 meters) east of wire fence; marked by peg driven flush with ground. True bearings: southeast corner post of inclosure, 150 feet (46 meters) 45°50′.1; right edge of flagpole at base, 300 feet (91 meters), 102° 27′.2; northeast corner post of inclosure, 170 feet (52 meters), 140° 01′.3.

Kumbara Island, 1915.—On northeast end of island, in tract fenced off for poultry, about 3 feet (1 meter) north of prominent palm tree which stands 6 feet (1.8 meters) north of path and approximately midway between the two gates of inclosure; marked by peg driven flush with ground. True bearings: near gable end of near bungalow, 230 feet (70 meters), 32° 53′.8; near gable end of large hut on Guadalcanar Island, 2½ miles (4 km.), 117° 33′.3; northern extremity of Neal Island, 3 miles (5 km.), 141° 02′.3.

Makambo Island, 1915.—At foot of hill northeast of wharf, 98 feet (29.9 meters) west of southwest corner of tennis-court, in line with east side of shed used for native quarters, and 171 feet (52.1 meters) north-northeast of its northeast corner; marked by peg projecting 1 inch (3 cm.) above ground. True bearings: near gable end of doctor's house at Tulagi, 12° 51′.1; base of flagpole on government house at Tulagi, 26° 20′.9; flagpole on front gable of storekeeper's house on hill, 900 feet (274 meters), 282° 46′.7.

Salicana Island, Manning Strait, 1915.—On south shore of island, about 300 feet (91 meters) west of jetty, and 11.5 feet (3.50 meters) inland from path running from jetty along foreshore to west, measured from point at which path turns sharply to north; marked by a wooden peg 2 by 2 inches (5 by 5 cm.) left 1 inch (3 cm.) above surface. True bearings: conspicuous white tree on Boundary Island, 1 mile (1.6 km.), 17° 04′.4; prominent palm tree on crest of main Waggina Island, seen across jetty, 5 miles (8 km.), 300° 03′.1; left-hand beacon on reef, 1.5 miles (2.4 km.), 354° 46′.2; right-hand beacon on reef, 358° 36′.5.

Simbo Island, 1915.—Near water's edge, on steeply rising ground densely covered with bush and coconut palms, on path leading from wharf past manager's residence to plantations on north side of bay, at a point about 400 feet (122 meters) east on path from manager's residence, 16 feet (4.9 meters) from nearest point of nearest native hut on south side of path, and 20 feet (6.1 meters) from nearest point of a similar hut on north side of path. True bearing: mark on east side of workshop near wharf, 900 feet (274 meters), 110° 40′.1.

Tulagi, 1915.—Near western end of shelf between high cliffs and shore-line, about one-fourth mile (0.4 km.) along path westward of jetty, about 300 feet (91 meters) east of Hollisé Brothers' engineering works, about 23 feet (7 meters) south of path, and 10 feet (3.0 meters), 15 feet (4.6 meters), and 16 feet (4.9 meters), respectively, from trees southwest, northeast, and south-southeast; marked by peg driven flush with ground. True bearings: northeast corner of veranda around Laycock's store, three-fourths mile (1.2 km.), 153° 17′.5; base of flagpole in front of storekeeper's house on Makambo Island, 212° 32′.0; left-hand leading beacon, 1¾ miles (2.8 km.), 235° 31′.0; right-hand leading beacon, 2 miles (3.2 km.), 261° 58′.7; left edge of shed on small jetty, 2,000 feet (610 meters), 307° 26′.5.

Warata Island, Marovo Lagoon, 1915.—Near center of island, about 240 feet (73 meters) northwest of northwest corner of manager's residence.

ISLANDS, PACIFIC OCEAN.

TOKELAU ISLANDS.

Atafu Island, 1915.—On sandy beach in front of pastor's house at south end of island, 191 feet (58.2 meters) southwest of flagpole seen through native hut, and 217 feet (66.1 meters) south-southwest of west corner of veranda of pastor's house. True bearings: west corner post of veranda of pastor's house at ground, 217 feet (66.1 meters), 193° 05′.6; left edge of flagpole at base, 191 feet (58.2 meters), 245° 22′.6; coconut tree on southern extremity of reef, 3 miles (4.8 km.), 347° 51′.3.

Fakaofu Island, 1915.—Near northern extremity of island, 105 feet (32 meters) east of path which runs round the island near the shore, 115 feet (35 meters) southeast of northeast corner of path; marked by peg set just below ground. Approximate bearing: northwest point Fonuamuli Island, 4 miles (6.4 km.), 210° 30′.

Swains Island, 1915.—In center of 16-foot (4.88-meter) square formed by four posts 18 inches (46 cm.) in diameter and projecting 2 feet (61 cm.) above coral beach, near landing place on west coast of island, about 300 feet (91 meters) east of high-water mark, and 380 feet (115.8 meters) northwest of large copra-drying shed. True bearing: near gable end of large copra-drying shed, 327° 54′.6.

TONGA ISLANDS.

Lifuka, Haapai Group, 1915.—On open ground fronting sea, south of jetty and customs shed, in line with fence on north side of street which leads from king's palace to sea, 64 feet (19.5 meters) west of southwest corner of this fence, 54 feet (16.5 meters) east of high-water mark, and 187 feet (57.0 meters) south of signal-pole; marked by peg set just below ground. True bearings: near gable end of court-house, 900 feet (274 meters), 0° 48′.6; left edge of roof of shed on jetty, 300 feet (91 meters), 158° 49′.2; left edge of signal-pole at ground, 187 feet (57.0 meters), 192° 19′.3; ornament on tower of king's palace, one-fourth mile (0.4 km.), 272° 55′.2.

Neiafu, Vavau Island, 1915.—On open grass plot in front of Free church and northeast of jetty, 50.5 feet (15.39 meters) north-northwest from north corner of pier marking station of Australian Eclipse Expedition of 1911, 192 feet (58.52 meters) from point on church fence in range with church belfry, and 50.5 feet (15.39 meters) northeast from westernmost tree of a row standing northwest and southeast, the next tree of the row being a few feet south of eclipse-pier; marked by peg set just below ground. True bearings: east corner of roof on Chatfield's store, 800 feet (244 meters), 3° 39′.7; spike on near gable end of customhouse, 1,000 feet (305 meters), 86° 04′.0; near ornament on belfry by church, 300 feet (91 meters), 217° 22′.9; left edge of top of roof of public meeting-house, 600 feet (183 meters), 288° 03′.8.

Nukualofa, Tongatabu Island, 1915.—On open grass plot at rear of post-office, in range between south corner of post-office and easternmost tree of a row standing parallel to the shore, 158 feet (48.16 meters) and 110 feet (33.53 meters), respectively, west-southwest and southwest from south and west corners of post-office, and 25 feet (7.6 meters) east-northeast from tree referred to; marked by peg set just below ground. True bearings: spike on tower of King's Church, 1,000 feet (305 meters), 127° 28′.2; left edge of iron railing around signal-pole, 300 feet (91 meters), 189° 20′.6; right edge of white house across bay, 5 miles (8 km.), 276° 03′.1; ornament on far gable end of Victoria Memorial Hall, 900 feet (274 meters), 354° 47′.2.

SPECIAL REPORTS

By J. A. Fleming, H. W. Fisk, and S. J. Barnett

NON-MAGNETIC EXPERIMENT BUILDING OF THE DEPARTMENT OF TERRESTRIAL MAGNETISM.

1. View from southwest.
2. Interior view.

CONSTRUCTION OF NON-MAGNETIC EXPERIMENT BUILDING OF THE DEPARTMENT OF TERRESTRIAL MAGNETISM.

By J. A. Fleming.

Preliminary experiments pertaining to fundamental problems in magnetism, made during 1918 in the main laboratory of the Department of Terrestrial Magnetism at Washington, D. C., showed the desirability of erecting on the Department's site, a non-magnetic building of special design, designated the "Experiment Building." For this purpose the Trustees of the Carnegie Institution of Washington made a special allotment of $10,000 to cover costs of construction of the proposed structure, inclusive of heating arrangements, electric circuits, laboratory tables, and other internal furnishings. The plans were prepared by the author, in conference with Dr. S. J. Barnett as to the various requirements, and in accordance with the Director's instructions. Effective assistance in the preparation of the plans was received from Mr. C. Huff, a member of the Department's construction and instrument staff.

The main requirements were: (*a*) a site sufficiently removed from the main laboratory to assure that the effects caused by the large amount of magnetic material and apparatus in that building would not seriously affect the desired uniformity of magnetic field inside the Experiment Building; (*b*) unusual rigidity and stability; (*c*) essentially non-magnetic construction in order to secure the required uniformity of magnetic field within the building; (*d*) provision against rapid temperature changes within the building in order to maintain such constancy of temperature as the experiments may require; and (*e*) style of architecture to be in general harmony with that of the Standardizing Magnetic Observatory[1] already on the grounds.

After careful consideration of suitable locations available for building purposes within the grounds of the Department, and after some tests had been made, a site (*E*), about 200 feet north of the main laboratory (*A*), was selected as shown in Figure 2. The site chosen made possible the economical utilization of the facilities and sources of supply of the laboratory (*A*) and of its extensive heating and electric equipment. It was not practicable to use the Standardizing Magnetic Observatory (see *B*, Fig. 2) for the experimental work in magnetism, since that building is constantly in use as a non-magnetic observatory for standardizations and intercomparisons of instruments, and for special observations.

Since the publication of Volume II, the site of the Department as shown in Figure 1 on page 187 of that volume has been increased by the addition of parcels to the north and at the southeast corner, while a part of the original site on the eastern side of the property has been disposed of by exchange. Accordingly, the total area of the Department site is now increased from 7.4 acres to about 8.8 acres; it is inclosed on the south and west by established highways and extends on the other boundaries, either to the center lines of proposed streets, or to the edges of streets actually in construction.

The construction of the Experiment Building could be begun in April 1919. Because of the scarcity of skilled labor and of most building materials in 1919, it was decided to use concrete as the main material of construction, selecting a cement which was so nearly non-magnetic that its distribution in the walls of the building would have practically no disturbing effect upon the uniformity of the magnetic field within the area of the experimental work. It also appeared that a double wall, thus providing a dead-air space, would offer the most feasible and economical arrangement for the desired protec-

[1] See Researches Dep. Terr. Mag., vol. II, pp. 185–200, 1915.

tion against sudden temperature changes inside the building. These considerations of the requirements thus led to the adoption of a concrete, hollow-wall, monolithic construction, using non-magnetic aggregates and non-magnetic brass reinforcement.

Accordingly, a type of double-wall, concrete construction built by what is known as the Van Guilder system was adopted for the Experiment Building. The machine used in this system is a double mold, without either bottom or ends. In starting a wall the machine is placed on the footing beginning at a corner, the two sides are filled and tamped with concrete mixed to a stiff consistency such as will allow the immediate release of the mold after filling, the mold then being pushed ahead ready for filling and tamping on the next section. Each such operation completes a portion of the double wall, approximately 9 inches high and 5 feet long. To get the strength and solidity of the construction desired the two sections of the wall were made 6 inches thick, being separated by a 2½-inch air space. This system leaves the dead-air space continuous except for the reinforcing rods tying the walls together. The operation of filling, tamping, and sliding the machine ahead is repeated until a complete circuit of the building is made, when the next 9-inch tier is started. It is possible to cast the hollow wall rapidly and to cast with one machine from 3 to 4 tiers per day.

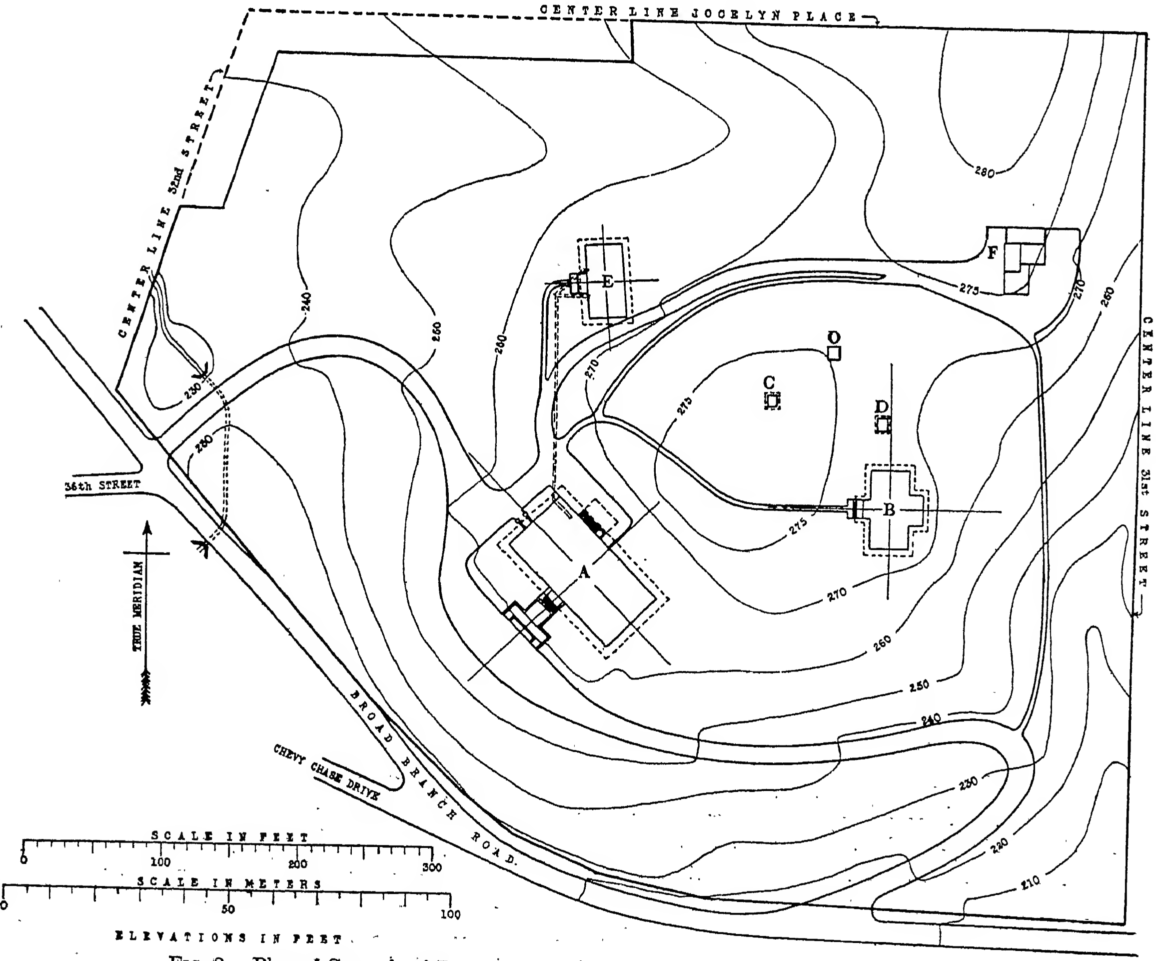


FIG. 2.—Plan of Grounds of Department of Terrestrial Magnetism, Washington, D. C.
A. Main laboratory. B. Standardizing Magnetic Observatory.
C and D. Accessory buildings. E. Experiment Building.
F. Foundry, storehouse, and stable.

Because of the requirement of non-magnetic construction, the reinforcement material used throughout for the concrete was of brass wire and brass rod; all necessary tie-bolts, lag-screws, tie-rods, nails, and hardware were of brass or bronze. The detailed cross-section (see Fig. 3) will serve to indicate the general character of the reinforcement.

The 13 drawings covering the details of the building, special electric installations with special switchboards, necessary switchboard extension in the main laboratory, various pipe-lines and outlet arrrangements, laboratory tables, and heating arrangements were completed in April 1919. The insulation against temperature changes within the building provided by the continuous, insulating, dead-air space between the two 6-inch walls was further increased by provision of double windows and double doors, by a double ceiling of plaster-board,[1] inclosing a 10-inch dead-air space between purlins, and by a 1-inch dead-air space between the two layers of plaster-board on the underside of the roof purlins.

Because of the unusual requirements and specifications, particularly those for non-magnetic construction, it was not possible to secure reasonable contracts for the work, which had, therefore, to be undertaken by the Department, and the author was assigned by the Director to take charge of the construction. It was impossible even to secure bids for the mill-work, all of which was special and had to be made in the wood-working shop of the Department. The rough grading and installation of rain-water drains and connections to culvert on the grounds were completed and the finished concrete foundations and floor were in place by April 26. The wide heavy footing-courses and the 3-inch concrete sub-floor were placed first and then waterproofed with 4 layers of felt and pitch, according to the specification given later, before the placing of the 6-inch thick concrete top floor. The 1-inch finished cement surface to the floor was cast at the same time as the top floor, thus obtaining the advantage of an additional inch of thickness in the structural strength of the concrete. The footings and concrete floor were all on original excavation, there being no fill under any of the floor or footings. The concrete walls were started March 12 and completed, including both gable ends to the ridge of the roof, by June 14.

The sill course around the building, the sills under the windows in the gable ends, and the columns and pilasters at the entrance were all made of concrete and cast in place, with fine granite-and-mica surfacing; the forms used in casting them were moved immediately after casting and the excess of white cement used in the surface treatment removed by water spray, thus bringing out the small granite-and-mica chips and producing an artificial stone having much the appearance of granite. The outside stucco finish above the sill level was of Portland cement stucco applied in three coats in accordance with the recommended practice for Portland cement stucco issued by the American Concrete Institute's committee on the treatment of concrete surfaces.[2] The aggregate of the surface finishing coat consisted of yellow sand, white Portland cement, and large-size, granite-and-mica chips so treated with water spray as to remove the film of cement and sand from the coarse aggregate. All of the granite and mica used for this work was tested and found to be non-magnetic. The color effect of this stucco finish harmonizes well with the general color scheme of the other buildings on the grounds. The interior of the building is plastered in hard sand finish, a pleasant buff color having been obtained by use of a yellowish sand in the final coat.

Because of the scarcity and excessive cost of materials it was necessary to substitute for the slate roof, as originally specified, a roof of felt shingles saturated and waterproofed with asphalt and covered with crushed natural slate of dark soft red color. This roof

[1] The board known as "sheetrock" was used; it is about three-eighths inch thick and is practically pure gypsum cast between heavy card-boards.

[2] Proceedings, American Concrete Institute, vol. 15, 1919.

harmonizes with the color detail of the Experiment Building as well as with the roofs of the other buildings on the grounds and has given very good service, being in first-class condition at the end of two severe winters.

It was originally intended to place the lead-sheathed copper cables for electric circuits, the pipe-lines for water, gas, compressed-air, steam, drain, and sewer in terra-cotta ducts. Since, however, this would have practically prohibited access without considerable expense for any necessary future repairs, and particularly for the addition of new pipe-lines or electric circuits between the main laboratory and the Experiment Building, a concrete-lined tunnel of inside width 20 inches and inside height 36 inches was constructed between the furnace room of the main laboratory and the Experiment Building. The small initial additional expense of this tunnel has already been fully justified. All the pipe systems except the steam, return, and sewer connections are suspended at the top of this tunnel. The various lead-covered, stranded copper-wire, electric circuits are laid on the floor of the tunnel. All of the structural work, including grading, inside plaster, outside stucco, mill-work, and the tunnel connection to the main laboratory, was completed in October 1919. Many difficulties and delays were caused by the scarcity and slow deliveries of materials and by the scarcity of suitable labor under the conditions prevailing during the period of construction.

The permanent equipment of the building, other than special instruments and appliances for the investigational work, is entirely non-magnetic in character. The heating is provided from the central low-pressure, steam-heating plant of the main laboratory (*A*), about 200 feet distant. The provision of non-magnetic radiation was solved by constructing in the Department shop radiators made of copper tubes 1⅝ inches outside diameter mounted between copper manifolds top and bottom. The total radiation estimated as necessary for the volume of the building was 450 square feet, but so far it has been found necessary to use only 4 radiators with a total radiation of 225 square feet.

As stated above, the steam, return, gas, hot-water, cold-water, drain, and compressed-air pipe-lines and lead-incased electric cables from the main laboratory are hung in the concrete tunnel. All of these lines and cables in the building, with their mountings, are non-magnetic; they are also non-magnetic in the tunnel from the building to a point 40 feet southwest of the outside southwest corner. From that point to the main building the various pipes and supports in the tunnel are of iron. The distance, 40 feet, was adopted after careful tests which showed that, for the number of pipes of necessary sizes to be installed in the tunnel running in a north-south direction, no appreciable disturbance of the Earth's horizontal-intensity field was experienced at that distance from the testing instrument. It will be readily understood that this question was important from an economic point of view because of the excessive cost of brass and copper piping as well as of the increased cost of satisfactorily installing such brass pipe-lines. Suitable provision is made by expansion joints to allow for expansion and contraction of the steam and hot-water pipe-lines. All pipes in the tunnel, except those for gas, sewer, and cold water, are covered with cellular asbestos covering; the cold-water line is covered with felt.

The provision for electric circuits consists of 10 complete circuits of No. 6 cable for direct current from storage battery in the main laboratory, 1 alternating-current power circuit of No. 4 cable, 1 alternating-current light circuit of No. 8 cable, 1 alternating-current circuit of No. 10 cable for special motor-generator, and 2 control circuits for special motor-generator. Advantage was taken of the provision made for double entry by placing instrument cases in the Experiment Building, on each side of the entry and, accordingly, in the north and south ends of these cases, panel-boards were inserted. Thus the means are provided by suitable switches, properly fused, for the

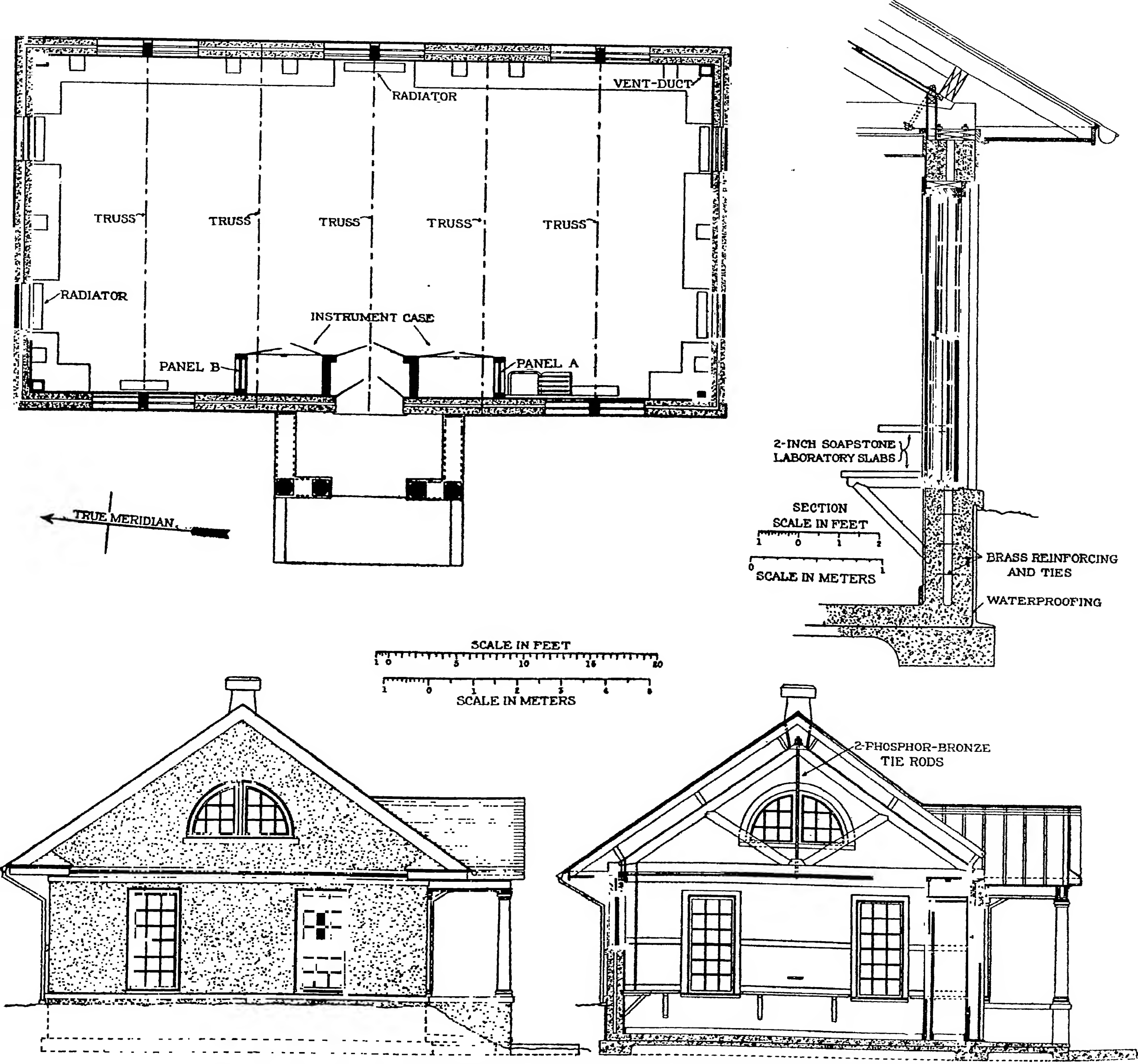


FIG. 3.—Plan, End Elevation, Cross-Section, and Detail Section of Non-Magnetic Experiment Building.

distribution of electricity by special leads within the building as the investigational work may require. These panel-boards are made of transite ebony asbestos-wood 1 inch thick, the panel-board cases being lined with thin asbestos-wood. Provision is made so that the boards may be extended to serve any future additional requirements. All switches, connections, plugs, and other electrical supplies necessary in the installation are strictly non-magnetic. Alternating-circuit plug outlets are provided at 16 points in the laboratory tables mounted along the walls of the building (see Fig. 3). Lighting is provided by six 100-watt nitrogen-filled lamps, mounted on the lower members of three of the roof trusses, and by 40-watt ceiling-fixtures in the entry and porch. Each of these lights has a separate switch in the frame of the north instrument-case. Standard hose-bibb and hose-cock connections for both hot and cold water, ½-inch compressed-air outlets, ¾-inch drain outlets, and ⅜-inch gas outlets are installed at 8 points in the laboratory tables. The pipe-lines concerned with these outlets and the brass conduits for the electrical connections are carried around the wall of the building below the soapstone tables.

The laboratory tables for the experimental work consist of soapstone slabs 2 inches thick, all carefully selected to be free of magnetic veins and impurities, and mounted on heavy wooden brackets suitably supported by lag-screws set in the inner concrete wall. They are 25 inches wide. The maximum length of slab is 5 feet, and where the slabs come together they are joined by key slot with flat brass key set in cement. The table tops are 40 inches from the floor. Special soapstone galvanometer shelves 2 inches thick are placed at 10 points (see Fig. 3). They extend through and are built in the inner 6-inch wall; the available shelf space is 13 inches by 13 inches. The tops are 54 inches above the floor.

The outside dimensions of the building are 28 feet by 53 feet; the inside clear height below the exposed roof trusses is 12 feet, and the height from the lower members of the roof trusses to the ridge of the ceiling is about 9 feet.

Ventilation is secured by three 20-inch copper ventilators as shown by Plate 8 and Figure 3. Those at the north and south ends of the building connect with 4 ducts running to the 4 corners and opening just below the soapstone laboratory tables, while that at the center opens directly into the building. The ventilators are provided with dampers in order that the amount of ventilation may be regulated, and also with fusible links so that in case of fire they will close automatically.

The total cost of construction, despite the increased costs arising from non-magnetic requirement for all building material, and including grading and the tunnel connection to the main laboratory, but exclusive of the permanent interior equipment, was $8,500; this is at an average rate of about 30 cents per cubic foot, and compares favorably with prevailing rates for ordinary lumber construction. The grading was an important item of cost, since it was necessary to excavate and grade not only for the building but also for a considerable distance to the south and east to provide a suitably graded roadway.

The following is a brief summary of the specifications:

Concrete.—All concrete to be one part first-class Portland cement, 2 parts clean, sharp, coarse sand, and 4 parts clean gravel (1½-inch and smaller for foundations and 1-inch and smaller for walls). All reinforcing and ties between walls to be brass wire or brass rod as indicated. Reinforced lintels, sills, and sill courses to be cast in place in wood forms and surfaced and treated as directed. All walls in contact with earth to be smoothly parged ⅝-inch thick with cement mortar made of one part fresh cement, 10 per cent hydrated lime-paste, and 3 parts of clean "down-river" sand.

Waterproofing.—Floor and exterior walls below grade as shown to be waterproofed with 4 layers felt and pitch, allowing 6 inches lap on every joint. A "waster" is to be placed to keep extension from floor clean and dry until the wall waterproofing is attached.

Plaster.—First coat one part approved prepared plaster to not more than 2 parts down-river sand; rough sand finish to be made to ¾-inch grounds.

Cement Stucco.—To be made up and applied in 3 coats in accordance with the recommended practice for Portland cement stucco issued in 1919 by the American Concrete Institute's committee on the treatment of concrete surfaces. Exposed aggregate to be granite and mica and treated as directed. Lathing, needed in gable of porch only, must be of wood nailed with copper nails.

Lumber.—Structural wood work, nailing blocks, furring strips, tongue-and-groove stuff for overhang, etc., must be of No. 1 well-seasoned Georgia pine or cypress. Tongue-and-groove stuff for roof sheathing to be well-seasoned Virginia pine.

Mill-Work.—All sash and doors to be of cypress 1¾-inch thick. Window and door frames and outside wood sills to be of No. 1 well-seasoned Georgia pine. All other interior trim to be No. 1 cypress. All sash and doors to be glazed with AA double-thick glass (zinc points to be used). No shutters are to be provided.

Hardware and Metal Work.—All metals used must be non-magnetic brass, copper, zinc, or lead, including nails, lag-screws, wood screws, pipes (inside and to all points within 40 feet of the outside of building), locks, lifts, sash pulleys, sash weights, etc. Rabbeted-face locks and flush bolts to be provided for the 2 entrance doors. All down-spouts, gutters, and flashings to be of 14-ounce copper.

Plumbing.—Sink to be of 1¾ white pine lead lined with 1½-inch waste to connect with sewer at main building and to be properly vented. Down-spouts to be connected to salt-glazed terra-cotta tile to grade at culvert. Cold-water, hot-water, gas, and compressed-air mains from main building are to be ¾-inch, ¾-inch, 1½-inch, and 1-inch respectively.

Electric Work.—Wiring and conduits for alternating-current and direct-current from main building are to be as shown by detail sheets.

Heating.—Low-pressure, single-pipe, return system from "Ideal" cast-iron boiler in main laboratory basement room (another section to be added to boiler); supply main 3-inch pipe to be carried in tunnel, return 1½-inch pipe, in accordance with detail drawings. All radiation and piping within 40 feet of the Experiment Building to be copper or brass.

MAGNETIC SURVEY OF BUILDING.

In the course of construction observations at different levels and at different points were made from time to time with compass-variometer No. 2 to guard against use of any magnetic material in the construction. At no time during the course of construction were any appreciable magnetic effects observed.

During March 12 to 24, 1920, a detailed magnetic survey of the interior of the finished structure, with permanent fixed equipment in place, was made by Messrs. W. F. Wallis and A. Sterling. The observations were made at 9 stations inside the building, and at 2 heights above the finished floor at each station. These stations were at the intersections of 3 north-south and 3 east-west lines, parallel to the length and width of the building, respectively, the eastern-most and northern-most lines being 6 feet 1 inch from the inside east and north walls; the second and third length-lines of stations were 12 feet 1 inch and 18 feet 1 inch, respectively, from the east wall, while the second and third east-west lines were 24 feet 1 inch and 42 feet 1 inch, respectively, from the north wall. While observations were being made at these stations by one observer, the other observer at a tenth station made simultaneous observations with his instrument, mounted on its regular tripod, to obtain data for the elimination of diurnal-variation effects. This tenth station was designated as *E8*, and was in the north-south line of stations on the east side of the building, 6 feet 1 inch from the east wall and 2 feet 5 inches from the south wall.

The observations were made with C. I. W. magnetometer-inductors Nos. 24 and 26, No. 26 being used at *E8* and No. 24 at the other stations. The 9 points above described were designated *E1*, *E4*, *E7*, *M1*, *M4*, *M7*, *W1*, *W4*, and *W7*, with the additions of the words *low* or *high* to indicate the station at the low level, when the suspended magnet was 1 foot above the floor, or at the high level, when the magnet was 3.4 feet above the floor. It had been planned originally to observe at intermediate stations on the north-south lines, to be spaced 6 feet apart and to be designated by the numbers 2, 3, 5, and 6, but the observations soon showed such uniformity in the magnetic field inside the building as to make additional stations unnecessary.

Plumb-lines were fixed for declination reference-marks at the north and south ends of the 3 rows of stations; auxiliary marks outside the building were established for the observations with magnetometer No. 26 at station *E8*. The horizontal-intensity observations were made partly by oscillations and partly by deflections, the values of *H* being computed, using the mean value of the magnetic moment derived from several complete determinations of intensity preceding and following the survey. The inclination values were determined with the earth inductors.

The following results were obtained from the magnetic survey of the interior of the Experiment Building.

1. A steady decrease in westerly declination from the north to the south end of the building, the total range being 6 minutes of arc for stations 1 to 7, the ranges for the high and low stations being practically identical for all stations. The average value of the declination was 4°.9 west.

2. A steady decrease in northerly inclination from the south to the north end of the building, the total range being slightly less than 2 minutes of arc for stations 1 to 7, the ranges for the high and low stations being of the same order. The average value of inclination was 71°.7 north.

3. A steady increase in horizontal intensity from the north end to the south end of the building, the total range being approximately 0.00025 C. G. S. for stations 1 to 7. The average value of horizontal intensity was 0.1878 C. G. S.

4. A slight increase in westerly declination and horizontal intensity and a slight decrease in northerly inclination from the east to the west sides of the building.

The small variation from absolute uniformity of magnetic field within the building arises from the following sources: (*a*) disturbance of the Earth's normal field by magnetic materials and equipment in main laboratory (*A*); (*b*) small natural local disturbance, amounting in a distance of 50 feet in the true meridian, as shown at the Standardizing Magnetic Observatory, to about one minute of arc in declination, about 0.00005 C. G. S. in horizontal intensity, and several tenths of a minute of arc in inclination; (*c*) very slight magnetic impurity of cement and possibly of aggregate; and (*d*) slight disturbance from the exterior earth embankment at the north end of building.

Inasmuch as the stations at the lower level were but one foot from the thick concrete floor, it must be concluded that the results of the tests were highly satisfactory. The investigational work (see Plate 8), performed by Dr. Barnett, in the Experiment Building since its completion, has shown that the desired requirements, as already enumerated, have been fulfilled.

DIP-NEEDLE ERRORS ARISING FROM MINUTE PIVOT-DEFECTS.

By H. W. Fisk.

The values of inclination presented in the tables of results of magnetic observations, in Volumes I, II, III, and IV of the "Researches of the Department of Terrestrial Magnetism," have been determined mainly by dip circles, depending in general upon observations with four needles at each station. The development of the earth inductor as a satisfactory field instrument has now been accomplished by the Department, and its use in the field, as shown by tabulated results and reports in this volume, has been sufficient under a variety of conditions to assure its success and remove all doubt as to the expediency of its general adoption. It has been amply demonstrated that the corrections of earth inductors on an adopted standard remain practically constant for all inclinations, and these corrections are known for the instruments in use certainly within 0′.5 and in general probably much nearer. With the dip circle on the other hand there is always an uncertainty greater than this. The reduction to standard of a series of field observations with a dip circle is one of the most tedious operations involved in the preparation of observations for publication and at the same time the least secure.

The methods heretofore followed in reductions for determination of corrections on adopted standard have been described in Volume I, page 45, and in Volume II, page 17, of the "Researches of the Department of Terrestrial Magnetism." The first method involves adjustment of corrections determined for different values of inclination, I, by use of the formula $F\Delta I = x + z \cos I + y \sin I$ where F is the total intensity and x, z, and y are coefficients obtained by least squares. It requires well-distributed comparisons with a reliable standard and has given good results whenever such comparisons were available; under these circumstances the method will control in a satisfactory way those general changes in the correction for a given needle which are known to take place where the instrument is used through widely varying inclinations. It does not take account of certain other changes in correction, sometimes of considerable magnitude, which persist only through limited ranges of inclination. The second method which, because of lack of sufficient distribution of reliable comparison-data, from necessity has been frequently used instead of the first, involves substantially an adjustment of needle-differences and the rejection of those needles showing erratic behavior. The four mean observed needle-differences for each group of several stations of nearly the same inclination are plotted and graphically adjusted so that the sum of any four corresponding graph-values of successive needle-differences will be zero, thus $[(a-b)+(b-c)+(c-d)+(d-a)]=0$, the corresponding values of inclination by the four needles being a, b, c, and d. Assuming that the mean correction for any one needle determined at one or more base-stations remains constant throughout an expedition, corrections for the other three needles at various inclinations are determined from the needle-difference graphs and the process repeated in turn assuming each of the other needles constant. A critical examination of the needle-difference graphs and of the four series of corrections obtained as above serves to reveal unusual accidental errors as well as those ranges of inclination over which one or more of the needles behaved badly, either because of pivot irregularities or deterioration. After rejecting such values, smoothed mean correction-curves are deduced.

In the case of certain expeditions reported upon in this volume, and for which the stations when arranged in the order of increasing inclination were densely distributed throughout the range of inclination, it was discovered that certain well-marked, short-

period variations in the correction-curves, not due to accident but possessing a characteristic symmetry, had been either obliterated in the process of taking the means as above outlined or rejected from the mean. To define more clearly these symmetrical variations for the purpose of studying their character and discovering, if possible, their cause, the method described in the following paragraphs was developed.

Wherever one needle varies persistently from the mean of the other three, and when this variation seems to follow a regular course as the inclination changes, or when a needle gives a value at a single station which bears an unusual relation to the others at that station, it is assumed that the mean of the three behaving normally is nearer the true value of the inclination than the mean of all. The erratic needle then can be corrected to the mean of the other three, and the value so corrected used for the further study of possible variations of a similar character in the others. Suppose we have four needles, Nos. 1, 2, 3, and 4, whose observed results at any station are a, b, c, and d. The successive differences, $(a-b)=m$, $(b-c)=n$, $(c-d)=p$, and, finally for check, $(d-a)=r$, are taken from the results at all the stations of a series arranged according to inclination and grouped so that there are, if possible, two to four group-values for each degree of inclination. Not knowing in advance which needle requires correction, similar differences are determined for all the needles, and trial-terms, δ, derived as follows:

$$\left.\begin{array}{ll} \delta_1=a-\frac{1}{3}(b+c+d) & \delta_2=b-\frac{1}{3}(a+c+d) \\ \delta_3=c-\frac{1}{3}(a+b+d) & \delta_4=d-\frac{1}{3}(a+b+c) \end{array}\right\} \quad (1)$$

Whence by substituting m, n, p, and r,

$$\left.\begin{array}{ll} \delta_1=\frac{1}{3}(3m+2n+p)=\frac{1}{3}(2m+n-r) & \delta_2=\frac{1}{3}(3n+2p+r)=\frac{1}{3}(2n+p-m) \\ \delta_3=\frac{1}{3}(3p+2r+m)=\frac{1}{3}(2p+r-n) & \delta_4=\frac{1}{3}(3r+2m+n)=\frac{1}{3}(2r+m-p) \end{array}\right\} \quad (2)$$

The expressions (2) will usually reveal the needle showing the largest variations and whether these variations are systematic. Assume that needle No. 1 shows such variations. Then since a appears in the expressions (1) for the first trial-term for each of needles Nos. 2, 3, and 4, each one must be modified by $\frac{1}{3}\delta_1$ giving the first error-terms, α, of the adjustment, as follows:

$$\alpha_1=\delta_1 \qquad \alpha_2=\delta_2+\frac{1}{3}\delta_1 \qquad \alpha_3=\delta_3+\frac{1}{3}\delta_1 \qquad \alpha_4=\delta_4+\frac{1}{3}\delta_1 \quad (3)$$

It frequently happens in the course of an expedition that more than one needle shows these systematic variations, and these may overlap, covering regions of the same inclination. For discovering such, the observed values corrected for first error-term, and designated a', b', c', and d', are treated in a manner analogous to that outlined for the original observations, and trial-terms, δ', for second error-terms in the adjustment are derived thus:

$$\left.\begin{array}{l} \delta_1'=a'-\frac{1}{3}(b'+c'+d')=a-\alpha_1-\frac{1}{3}(b+c+d)+\frac{1}{3}(\alpha_2+\alpha_3+\alpha_4) \\ \delta_2'=b'-\frac{1}{3}(a'+c'+d')=b-\alpha_2-\frac{1}{3}(a+c+d)+\frac{1}{3}(\alpha_1+\alpha_3+\alpha_4) \\ \delta_3'=c'-\frac{1}{3}(a'+b'+d')=c-\alpha_3-\frac{1}{3}(a+b+d)+\frac{1}{3}(\alpha_1+\alpha_2+\alpha_4) \\ \delta_4'=d'-\frac{1}{3}(a'+b'+c')=d-\alpha_4-\frac{1}{3}(a+b+c)+\frac{1}{3}(\alpha_1+\alpha_2+\alpha_3) \end{array}\right\} \quad (4)$$

These equations by use of (1), (3), and the condition $(\delta_1+\delta_2+\delta_3+\delta_4)=0$, become:

$$\delta_1'=0 \qquad \delta_2'=-\frac{1}{3}\alpha_2 \qquad \delta_3'=-\frac{1}{3}\alpha_3 \qquad \delta_4'=-\frac{1}{3}\alpha_4 \tag{5}$$

Supposing that needle No. 4 shows variations from the mean which need further correction, the second error-terms are deduced thus:

$$\alpha_1'=\delta_1'+\frac{1}{3}\delta_4' \qquad \alpha_2'=\delta_2'+\frac{1}{3}\delta_4' \qquad \alpha_3'=\delta_3'+\frac{1}{3}\delta_4' \qquad \alpha_4'=\delta_4' \tag{6}$$

If there are more than two of the four needles in need of correction within any given region, the problem is indeterminate, though where the variations overlap but slightly their presence may be detected by a graphical process. Where there are two such erratic needles, doubt often arises as to which should be corrected on the first trial, and it is evident that the absolute value of the resulting error-terms will vary with the magnitude of the δ chosen since each preliminary trial-term is increased by $\frac{1}{3}\delta$. The final corrections of the four needles will retain the same relation independent of the choice made. In such cases the choice must depend on the relations between the needles in contiguous regions, where inclinations vary but slightly, and where the observations were made at about the same time. This process of analysis may be quite easily and rapidly performed by arranging the work in suitable tables, each step in the process furnishing its own check; the differences between the resulting corrections should agree very closely with the needle-differences of the groups from which they were derived. Assuming that the mean of all needles in a given instrument requires a constant correction, Δ, independent of the value of the inclination (the assumption upon which the present method is based), the correction ΔI_n for any needle, n, becomes

$$\Delta I_n=\Delta-(\alpha_n+\alpha'_n) \tag{7}$$

To illustrate the features of short-period corrections of the character under consideration, several examples are presented. The first is taken from the work of Observer F. Brown during March to July 1915 in eastern China with dip circle No. 177 using needles Nos. 1, 2, 5, and 6. In this case the stations are not as closely arranged as is desirable, but the values are sufficiently well verified to warrant their use. The correction-curves as actually applied to these observations (see p. 14) were smoothed somewhat more than the ones shown in Figure 4, in which the individual points as they were

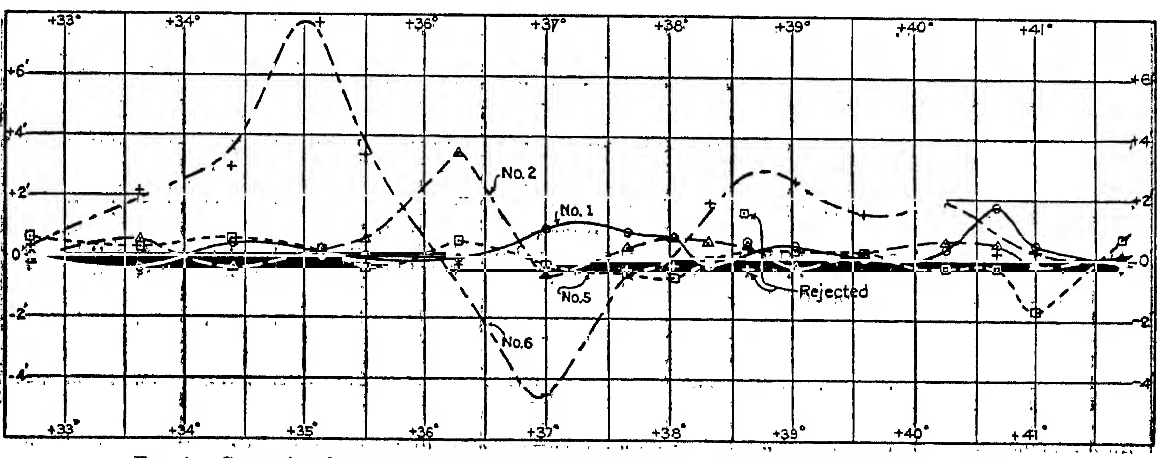


FIG. 4.—Correction-Curves for Needles used with Circle No. 177 during March to July 1915.

derived from the computation are shown. The correction for No. 6 at the maximum and the minimum is derived in each case from observations at a single station, but at both of these stations the observer suspected the results given by this needle and checked them by repetition. They may, therefore, be accepted as free from accidental error. It sometimes happens that a single accidental variation, apparently not a part of a system, will appear and must be eliminated before the systematic variation is fully defined. Such a point is found in the curve for No. 2 at 36°.27. This outstanding value depends upon the observations at a single station and does not necessarily signify that there is an irregularity in this needle corresponding to this elevation in the curve. It should be borne in mind, however, that the distribution of the four points along any ordinate is determined by the observations and does not depend upon the computation. Any modification of the computation that would result in changing the ordinate of one curve at any point must change the ordinates of the other curves at the same point by an exactly equal amount since this relation is fixed by needle-differences. Hence it will be seen that to reduce the ordinate of the curve for No. 2 at 36°.27 would seriously disturb the curves for both No. 1 and No. 5, while the curve for No. 6 which chances to

TABLE 45.—*Analysis for Behavior of Needles 1, 2, 5, and 6 in Dip Circle No. 177, March to July, 1915.*

Date	Mean I	Needle difference				Adjustment for needle errors							
		1—2	2—5	5—6	6—1	First trial-term				First error-term			
		m	n	p	r	δ_1	δ_2	δ_5	δ_6	α_1	α_2	α_5	α_6
1915	°	′	′	′	′	′	′	′	′	′	′	′	′
July 20	+32.7	−0.1	+0.7	−0.2	−0.4	+0.30	+0.43	−0.50	−0.23	+0.13	+0.26	*−0.50*	−0.40
July 17	+33.6	+0.9	−0.2	+1.8	−2.5	+1.37	+0.17	+0.43	−1.97	+0.71	−0.49	−0.23	*−1.97*
July 10, 12	+34.4	−0.8	+1.0	+2.3	−2.5	+0.63	+1.70	+0.37	−2.70	−0.27	+0.80	−0.53	*−2.70*
Mar. 24	+35.2	+0.1	0.0	+7.6	−7.7	+2.63	+2.50	+2.50	−7.63	+0.09	−0.04	−0.04	*−7.63*
July 5	+35.5	+0.5	−0.9	+3.7	−3.3	+1.13	+0.47	+1.67	−3.27	+0.04	−0.62	+0.58	*−3.27*
July 2	+36.3	+3.5	−2.9	−0.8	+0.2	+1.30	−3.37	+0.50	+1.57	+0.18	*−3.37*	−0.62	+0.45
Mar. 30	+37.0	−1.6	+0.4	−4.2	+5.4	−2.73	−0.60	−1.13	+4.47	−1.24	+0.89	+0.36	*+4.47*
April 1, June 27	+37.6	−0.6	−0.8	+0.1	+1.3	−1.10	−0.30	+0.77	+0.63	−0.89	−0.09	+0.98	*+0.63*
April 2	+38.0	+0.2	−1.5	+0.3	+1.0	−0.70	−0.97	+1.03	+0.63	−0.49	−0.76	+1.24	*+0.63*
June 21	+38.3	+0.8	−0.6	+1.9	−2.1	+1.03	−0.03	+0.77	−1.77	+0.44	−0.62	+0.18	*−1.77*
April 15	+38.6	+1.0	−1.1	−0.8	+0.9	+0.00	−1.33	+0.13	+1.20	+0.40	−0.93	+0.53	*+1.20*
April 5, June 16	+39.0	−0.7	+0.6	+2.2	−2.1	+0.43	+1.37	+0.57	−2.37	−0.36	+0.58	−0.22	*−2.37*
April 11, 24	+39.6	+0.1	+0.1	+1.2	−1.4	+0.57	+0.43	+0.30	−1.30	+0.14	0.00	−0.13	*−1.30*
June 9, 12	+40.3	+0.2	−0.8	+2.2	−1.6	+0.40	+0.13	+1.20	−1.73	−0.18	−0.45	+0.62	*−1.73*
April 28, June 3	+40.7	−1.2	−0.8	+0.5	+1.5	−1.57	+0.03	+1.10	+0.43	*−1.57*	−0.49	+0.58	−0.09

Date	Mean I	Adjustment for needle errors—*continued*								Correction on adopted standard $\Delta I = 0.'1 - (\alpha + \alpha')$			
		Second trial-term				Second error-term							
		δ_1'	δ_2'	δ_5'	δ_6'	α_1'	α_2'	α_5'	α_6'	No. 1	No. 2	No. 5	No. 6
1915	°	′	′	′	′	′	′	′	′	′	′	′	′
July 20	+32.7	−0.04	−0.09	0.00	+0.13	0.00	−0.05	+0.04	*+0.13*	0.0	−0.1	+0.6	+0.4
July 17	+33.6	−0.24	+0.16	+0.08	0.00	*−0.24*	+0.08	0.00	−0.08	−0.4	+0.5	+0.3	+2.1
July 10, 12	+34.4	+0.09	−0.27	+0.18	0.00	0.00	*−0.27*	+0.09	−0.09	+0.4	−0.4	+0.5	+2.9
Mar. 24	+35.2	−0.03	+0.01	+0.01	0.00	*−0.03*	0.00	0.00	−0.01	0.0	+0.1	+0.1	+7.7
July 5	+35.5	−0.01	+0.21	−0.19	0.00	+0.06	*+0.21*	−0.12	+0.07	0.0	+0.5	−0.4	+3.3
July 2	+36.3	−0.06	0.00	+0.21	−0.15	+0.01	+0.07	*+0.21*	−0.08	−0.1	+3.4	+0.5	−0.3
Mar. 30	+37.0	+0.41	−0.30	−0.12	0.00	*+0.41*	−0.16	+0.02	+0.14	+0.9	−0.6	−0.3	−4.5
April 1, June 27	+37.6	+0.30	+0.03	−0.33	0.00	+0.19	−0.08	*−0.33*	−0.11	+0.8	+0.3	−0.5	−0.4
April 2	+38.0	+0.16	+0.25	−0.41	0.00	+0.02	+0.11	*−0.41*	−0.14	+0.6	+0.8	−0.7	−0.4
June 21	+38.3	−0.15	+0.21	−0.06	0.00	−0.08	*+0.21*	+0.01	+0.07	−0.3	+0.5	−0.1	+1.8
April 15	+38.6	−0.13	+0.31	−0.18	0.00	−0.03	*+0.31*	−0.08	+0.10	−0.3	+0.7	−0.3	−1.2
April 5, June 16	+39.0	+0.12	−0.19	+0.07	0.00	+0.06	*−0.19*	+0.01	−0.06	+0.4	−0.3	+0.3	+2.5
April 11, 24	+39.6	−0.05	0.00	+0.04	0.00	*−0.05*	−0.02	+0.02	−0.02	0.0	+0.1	+0.2	+1.4
June 9, 12	+40.3	+0.06	+0.15	−0.21	0.00	−0.01	+0.08	*−0.21*	−0.07	+0.3	+0.5	−0.3	+1.9
April 28, June 3	+40.7	0.00	+0.16	−0.19	+0.03	−0.06	+0.10	*−0.19*	−0.03	+1.7	+0.5	−0.3	+0.2

fall near normal at this point could as well be drawn for one condition as for the other. In this case the result is controlled by needles No. 1 and No. 5, which are chosen on the evidence of adjacent stations. The complete analysis to determine the corrections starting from observed needle-differences is given in Table 45.

The second example, shown by Figure 5, illustrates a similar case from a region of southerly or negative inclination. This short expedition comprises 21 stations in South Australia, at which the observations were made by Observer A. L. Kennedy in 1914 using circle No. 41 with needles Nos. 1 and 2 of No. 178 and Nos. 5 and 6 of No. 41. Of these needles the correction for No. 5 only had been determined by comparison, and that at some time previous in a region of different inclination. Assuming the correction thus determined to have remained constant, the corrections for the other 3 were worked out by the foregoing method. The amplitude of the variation of needle No. 6 is greater and takes place within a range of inclination less than has been found in other cases.

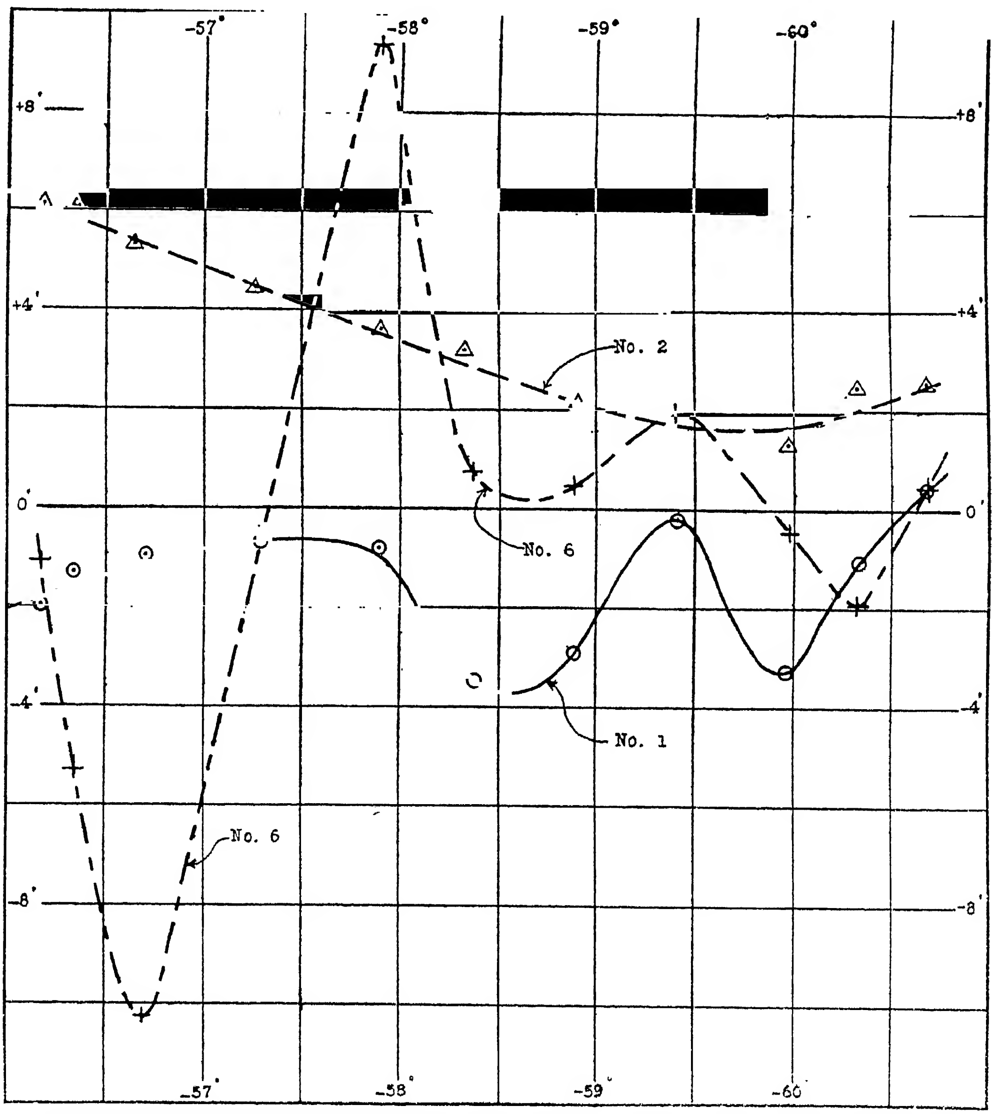


FIG. 5.—Correction-Curves for Needles used with Circle No. 41 during 1914. (The 21 stations are grouped as indicated by plots for each needle.)

The stations are so well distributed that the graphs show beyond question the relative corrections for the several needles.

A third example involving a more extended expedition and short-period variations for several of the needles is shown in Figure 6 from the work of Observer F. Brown with circle No. 177 using needles Nos. 1, 2, 5, and 6. This expedition, beginning from a point northwest of Peking, China, in August 1915 and terminating at Pehtaiho east of Peking in July 1916, gave a complete circuit, crossing isoclinics +52° to +67° on the outward journey and recrossing them later on the return. The values of inclination, when arranged in order of magnitude, lie very close together at intervals separated by some months and afford favorable conditions for investigation. Mr. Brown, the observer, was more than usually alert to note and to verify any apparently abnormal values given by any needle, and thus the danger that any conclusions may be seriously affected by accidental or observational errors is reduced to a minimum. The correction-curves for the four needles as finally adopted and given in Figure 6 show, besides several small undulations, the amplitudes of which are of the order that might be expected from purely accidental causes, others which present striking peculiarities. With the exception of the large variation shown in the curve for needle No. 1 (which will receive special consideration

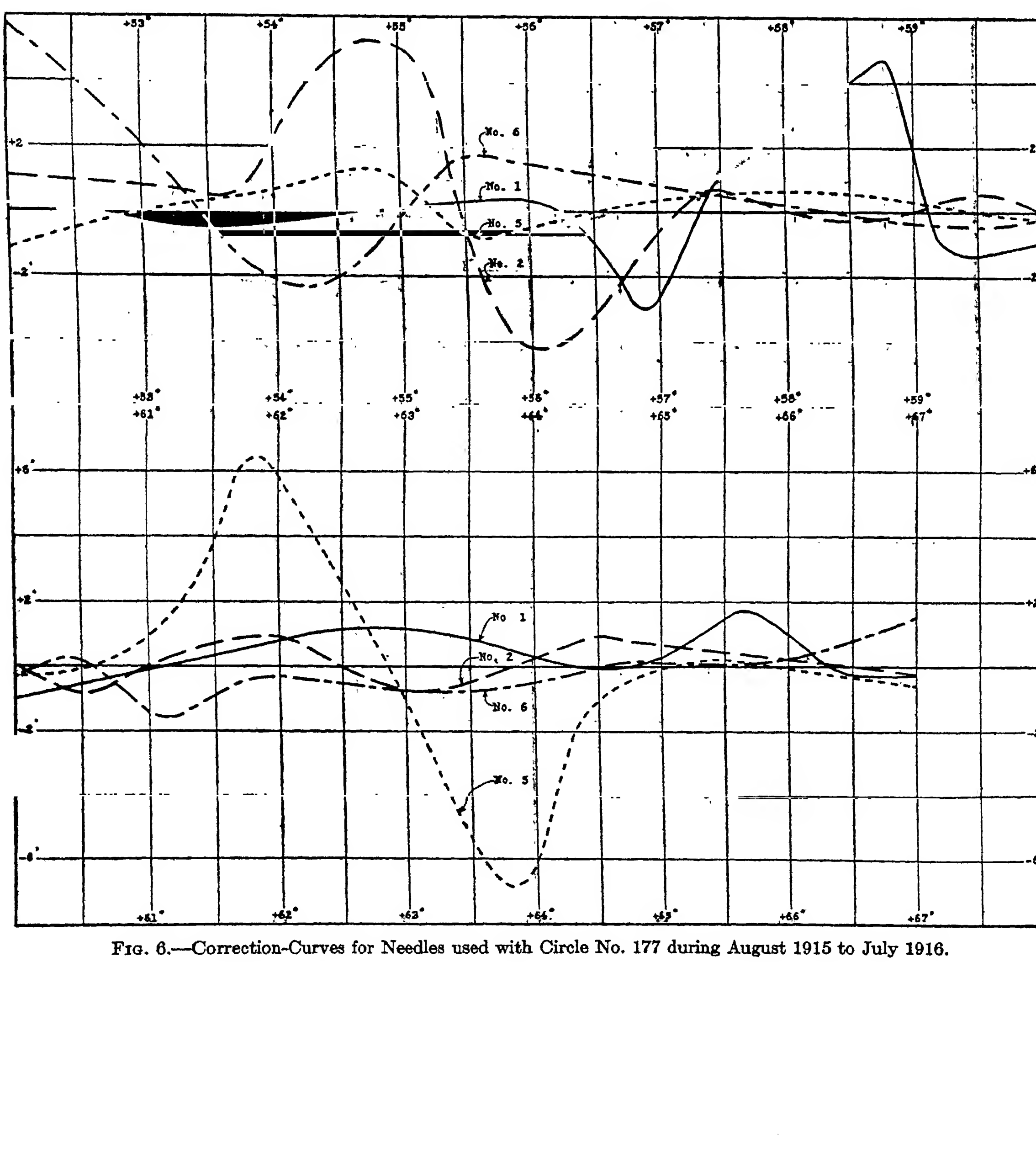


FIG. 6.—Correction-Curves for Needles used with Circle No. 177 during August 1915 to July 1916.

later), these larger undulations are quite similar in form. The range of inclination covered only a part of such an undulation in the curve for No. 6; the undulation in the curve for No. 2 is characteristic and unmistakably defined; that in the curve for No. 5 is of larger amplitude and extends over a somewhat wider range of inclination than those in the curves for the other two needles. Each of these, again excepting that in the curve of No. 1, first rises to a positive maximum as inclination increases and later falls to a corresponding negative value, the ratio of the amplitude to the range of inclination through which this feature extends being roughly the same in all the cases.

In the curve for needle No. 1, between the values of inclination +56° and +59°.5, the order of minimum and maximum seems to be reversed, the minimum in this case preceding the maximum, and the figure lacks the symmetry of form suggested by the curves for Nos. 2, 5, and 6. The values given by needle No. 1 had to be rejected within this range of inclination, being too discordant to be used in the mean of the other needles. Several attempts were made to alter the grouping of the stations within these limits so as to make it possible to draw a smooth curve. No satisfactory grouping was found. An examination of the original observations disclosed that a radical change in polarity-difference of needle No. 1 occurred some time between May 10 and May 17, 1916, probably between the two sets of observations on May 14. Table 46, giving chronological groupings usually for three stations, shows how this change affected the relation of the observed results with polarity *A* and polarity *B*.

TABLE 46.—*Tabulation of Observed Data during January 1 to July 3, 1916, with Needle No. 1 in Dip Circle No. 177.*

Date	Adopted inclination, I	$(I-1A)$	$(I-1B)$	$(A-B)$
1916	° ′	′	′	′
Jan. 1, 4, 8	+58 58	−16.6	+16.0	+32.6
Jan. 13, 17, 25	+56 28	−17.0	+18.9	+35.9
Jan. 26, 30; Feb. 2	+54 39	−19.3	+19.1	+38.4
Feb. 6, 10, 13	+53 48	−20.2	+19.0	+39.2
Feb. 25; Mar. 2, 17	+52 52	−21.8	+21.1	+42.9
Mar. 27, 30; April 3	+54 22	−21.9	+21.7	+43.6
April 6, 11, 24	+56 09	−19.0	+19.8	+38.8
April 27; May 2, 5	+58 46	−17.8	+14.9	+32.7
May 10, 14 (1)	+58 55	−15.8	+10.3	+26.1
May 14 (2)	+58 23	+ 7.5	− 1.6	− 9.1
May 17, 18, 21	+58 39	+ 6.2	+ 2.7	− 3.5
May 24, 27, 30	+58 30	+ 4.6	+ 2.8	− 1.8
June 1, 2, 7	+58 07	+ 0.8	+ 3.6	+ 2.8
June 16, 28	+56 45	− 8.8	+ 6.6	+15.4
July 1, 3	+56 51	− 9.7	+ 3.4	+13.1

Needle No. 1 was not used after July 3, 1916. The cause of this sudden change in the behavior of this needle is not clear. The range in the inclination concerned is relatively small, so that any change in balance due to a physical change in the blade would be sensibly constant for all the observations after the date of occurrence, while any accident to the pivot would affect only the results of one polarity of the needle. Possibly there may have been some combination of both of these conditions. Treating the observations before and after May 14 separately, the resulting correction-curves for needle No. 1 are shown in Figure 7 and indicate clearly a time-change.

Referring again to the short-period variations on correction-curves, it is quite certain that those of larger magnitude are not caused by accidental observational errors. Such results are obviously attributable to minute defects of pivots produced by corrosion,

abrasion, or otherwise. Examination of pivots under a high-power microscope often shows rust scars or pits of considerable magnitude; extended field experience shows that such oxidation takes place readily, especially in the tropics, despite utmost care. In the cases which have been analyzed, these large deviations in the correction-curves are nearly always such as would be produced by an elevation rather than by a depression on the pivot, that is, the maximum precedes and the minimum follows as the inclination increases. As the pivot rolls upon such an elevation with increasing northerly inclination, the needle is at first restrained, giving too small a reading and requiring a positive correction, and then pitches forward over the obstruction, giving too large a reading and requiring a negative correction. Following the usual convention as to sign of southerly inclination the order of maximum and minimum would be reversed in the southern hemisphere (compare Fig. 5). So far no clearly defined case such as would be produced by a simple depression has been revealed; the case of needle No. 1 of circle No. 177, which at first seemed to be of that type, was, as indicated, a combination of other causes not evident from the available data. It is not apparent why curves of the one type should predominate since the microscope shows that pits or scars are often present. It may be that, since the pits are a later development, the behavior of the needle has become so bad by the time they appear as to defy analysis or to cause the rejection of the needle.

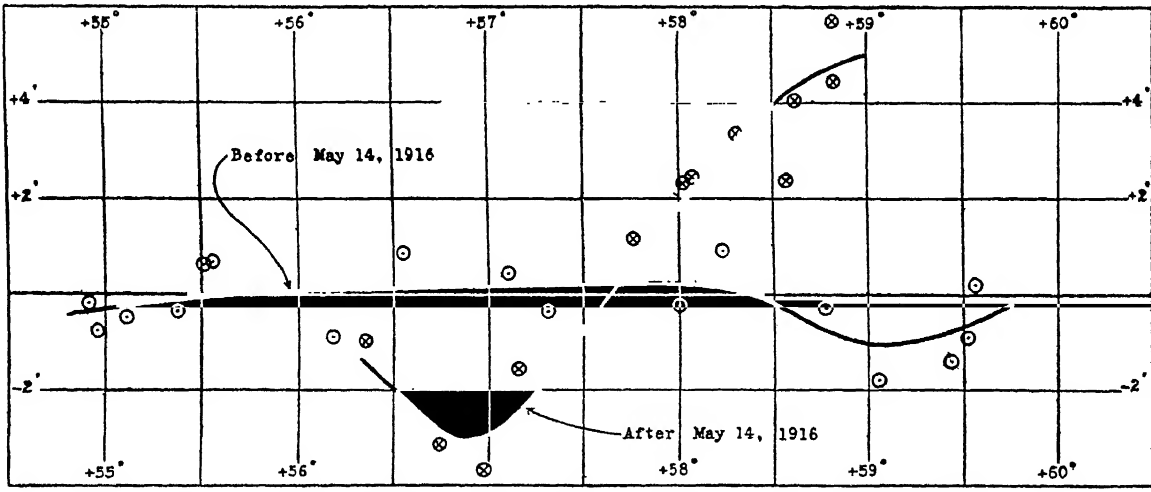


FIG. 7.—Showing Time-Change in Correction-Curve for Needle No. 1 of Circle No. 177.

To determine whether a rust particle adhering to the axle could produce undulations in the correction-curves of the dimensions observed, assume the particle to be of such form that tangents drawn from its apex to the circumference of the pivot do not touch it at any other point. In Figure 8*a*, representing an enlarged cross-section of a pivot through the point of support, let CM be the direction of the magnetic axis of the needle, which coincides with CI, the direction of the magnetic field of intensity F, the needle being in equilibrium upon the apex of the rust particle; TG and $T'G$ are tangents drawn from the apex to the circumference of the pivot, and 2θ is the angle between the radii to the points of tangency. In Figure 8*b*, assume the field to have changed in direction through the small angle β, which will cause the needle to roll forward, throwing the center of gravity ahead of the point of support so that the needle will rotate through an additional angle ϵ until equilibrium is established with the magnetic axis taking the direction CM according to the condition expressed in the equation

$$wgr \sin(\beta+\epsilon) = Fm \sin \epsilon \tag{8}$$

where w is weight of needle in grams, g is acceleration of gravity, r is radius of axle at point of support, and m is magnetic moment of the dip needle. Of these quantities, w, g, r, and m are constant for any needle, though m will vary slightly according to the treatment the needle receives. If freshly magnetized with bar magnets of sufficient strength before each set of observations, the moment will be fairly well maintained. Now, if we write $\frac{wgr}{m}=A$, equation (8) becomes

$$A \sin(\beta+\epsilon)=F \sin\epsilon \tag{9}$$

whence, since β and ϵ are small angles,

$$\epsilon=\left(\frac{A}{F-A}\right)\beta \tag{10}$$

Equation (10), however, holds only while the needle is turning from the position shown in Figure 8a through the angle θ, when it will rest upon the tangent TG. At that point the maximum ϵ occurs, and we have

$$\epsilon_{max.}=\theta-\beta=\left(\frac{A}{F}\right)\theta \tag{11}$$

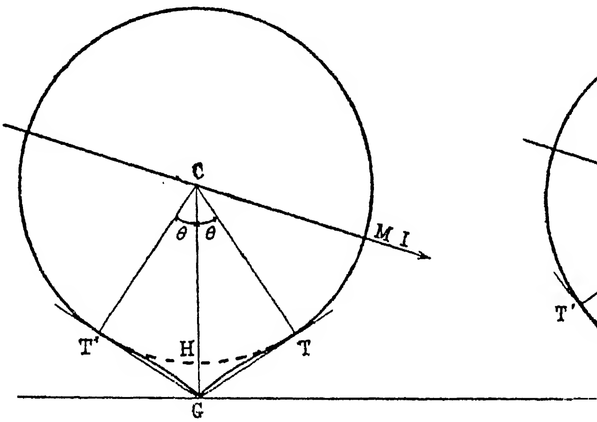


FIG. 8a.

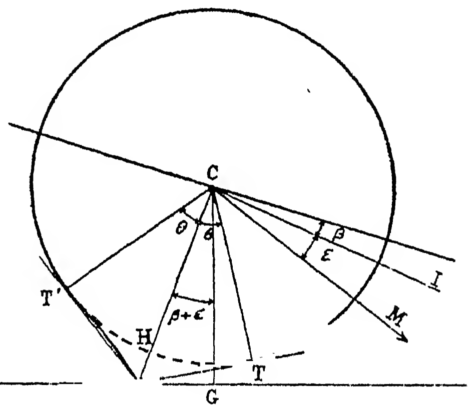


FIG. 8b.

Theory of Minute Pivot-Defects on Dip-Needle Axles.

As β still further increases, the direction, CM, of the magnetic axis of the needle (Fig. 8b) remains fixed and is gradually approached by the direction of the field CI. Hence, over this portion of the curve the relation between β and ϵ is simply

$$\beta+\epsilon=\theta \tag{11a}$$

Now the angle ϵ has been taken so as to represent the *error* which would be introduced into the observed value in a single position of the needle if the weight of the needle were all upon the irregular end of the pivot. Since a complete determination of inclination with a needle requires readings to be made in four positions, the other three being presumably unaffected, and since the weight rests equally upon the two ends of the pivot, the maximum *correction* produced by a particle of rust as assumed would be

$$\Delta I_n=-\frac{1}{8}\left(\frac{A}{F}\right)\theta \tag{12}$$

The constant A was determined for each of 10 needles taken at random from those in stock; 8 were of the usual land type as made by Dover, and 2, also made by Dover,

were of the slightly larger type used with the universal magnetometer of the Department (see p. 6). The resulting weights, magnetic moments, and constants for each of the 10 needles are shown in Table 47. Equation (8) assumes that ϵ and β are of the same sign, that is, that $(F-A)$ is positive when there is equilibrium. Table 47 shows that values of A for different needles lie within the range of values of F and thus under certain conditions $\frac{\epsilon}{\beta}$ will be negative, signifying that for such cases equilibrium will be impossible

TABLE 47.—*Tabulation Showing Values of Constants for Selected Dip Needles.*

Needle number	Weight, w	wgr[1]	Magnetic moment, m	$A=\frac{wgr}{m}$	Needle number	Weight, w	wgr[1]	Magnetic moment, m	$A=\frac{wgr}{m}$
	grams		*c. g. s.*			*grams*		*c. g. s.*	
17X..........	3.98	97.5	224	0.435	6 of 177.......	3.75	91.9	194	0.474
18X..........	4.00	98.0	221	0.443	1 of 171.......	4.01	98.2	194	0.506
1 of 202.......	3.70	90.6	202	0.449	2 of 171.......	3.99	97.8	191	0.512
2 of 202.......	3.70	90.6	203	0.446	2 of 19	4.98	122.0	245	0.498
1 of 177.......	3.85	94.3	190	0.496	6 of 19	4.97	121.8	249	0.489

[1] Using $g = 980$ cm. and $r = 0.025$ cm.

for any values of β between $+\theta$ and $-\theta$ when the needle will rest upon the tangents TG or $T'G$ (Fig. 8a). Hence, all needles are more unsteady when used in regions of low total intensity. This deduction agrees with common experience, and observers will recognize the condition of instability as one where the needle "bumps" and will take up either of two quite different positions equally well.

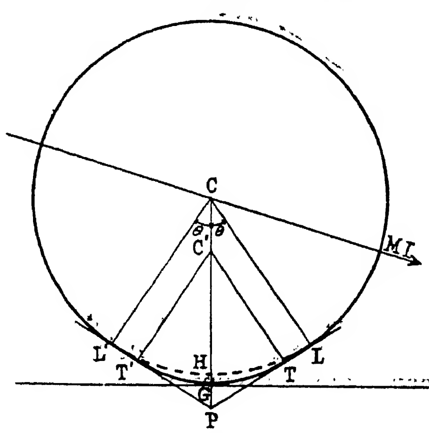


FIG. 9a.

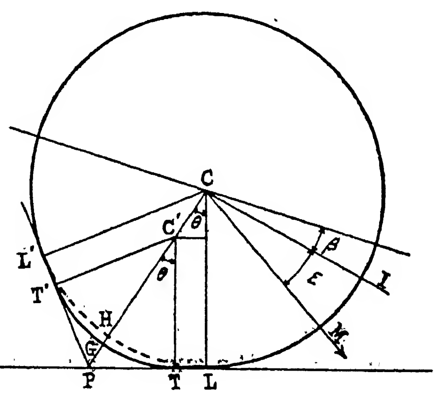


FIG. 9b.

Theory of Minute Pivot-Defects on Dip-Needle Axles.

In equation (11) the angle θ represents one-half the range of inclination over which the effect of the rust particle extends, so that a comparison between the range and the amplitude may be made for any assumed case. Thus as an average condition for $A=0.480$ and $F=0.600$ from (12) we have $\Delta I_n = -0.1\theta$. Reference to the correction-curves given in Figures 4, 5, and 6 shows θ will be about 2° to 2°.5 for an average case, so that the maximum correction to be expected under the above assumptions would be of the order 15′. This order of correction is approximated only in one case examined, viz, that shown by Figure 5; hence it is improbable that the short-period deviations are caused by rust particles of this simple form.

Rust patches will, of course, take on an indefinite variety of irregular forms, among which there may be such as would cause the short-period variations under discussion. Suppose a rust mass, such that a cross-section through it at the point of support will have a circular outline with radius r', the center of curvature being at C', as shown in Figures 9*a* and 9*b*, in which C is the center of the axle, LTP and $L'T'P$ are the common tangents to the two surfaces, CL and CL' are the radii drawn to the points of tangency on the axle, the angle between which is 2θ. If CI represents the direction of the field when the needle is in equilibrium at rest upon the point G and the direction of the field is changed by a small increment β, then the needle will roll forward under the influence of gravity through a small angle ϵ until a new equilibrium is established. This will occur when

$$wg(r+h-r')\sin(\beta+\epsilon)=Fm\sin\epsilon \tag{13}$$

where h represents the thickness, HG, of the rust patch at its center; h may be disregarded without appreciable error, as it is very small in comparison with the radius of the axle. Since $HP=r$ (sec $\theta-1$) and $GP=r'$ (sec $\theta-1$) it follows that

$$h=(\sec\theta-1)\ (r-r') \tag{14}$$

Thus for $\theta=2°$ the thickness of the rust patch at its center would be only 0.0006 $(r-r')$.

Hence from (13), placing $\dfrac{wg\,(r-r')}{m}=A'$,

$$\epsilon=\frac{A'}{F-A'}\beta \tag{15}$$

Since for maximum value of ϵ, $\beta+\epsilon=\theta$,

$$A'=\frac{\epsilon_{max.}\,F}{\theta} \tag{16}$$

An application of these formulæ may be made to data taken from the curve for needle No. 5 between inclinations $+61°$ and $+64°.5$ (see Fig. 6). For this case β, the angle of inclination-change between the center of symmetry and the maximum values of ΔI_n, is approximately 60′, and 2θ, the range in inclination between the beginning and ending of the short-period variation, is approximately 3°.6; hence from equation (11) $\epsilon_{max.}$ is 48′ approximately. The average value of F over the range of inclination involved is 0.55 c. g. s. From these data and equation (16) we have $A'=0.244$, and from equation (15) computed corrections, $\Delta I_5=\pm 0.100\beta$ between maximum and minimum, and $\Delta I_5=\pm 0.125\,(\theta-\beta)$ beyond the maximum and minimum, as seen by equation (11) and shown in Figure 10. The adjusted corrections from observations, each from a group of separate stations, are indicated in the figure and show a substantial agreement with the values computed on the above basis. The dimensions of a rust mass that would produce the short-period variation as above may be computed approximately. Since $A\,(r-r')=A'r$ and taking A for needle No. 5 as 0.474[1] and r as 0.025 cm. the value of r' for $A'=0.244$ is 0.012 cm., whence, from (14) for $\theta=1°.8$ as above, $h=0.000006$ cm. approximately. The diameter of the rust mass on the pivot would be about 0.002 cm.

The behavior of needle No. 1 in circle No. 177 indicated that conditions causing changes in correction-curves may arise suddenly during field work. There is also evidence that the short-period variations are not necessarily permanent. Evidence of this is found in the behavior of needle No. 5 in circle No. 177 which showed large short-period variations between inclination $+61°$ and $+65°$ during the expedition in Mongolia (Fig. 6). At the conclusion of that expedition a shorter trip was made by Observer

[1] Needle No. 5 was broken in the field and was not available for the determination of A; the value determined for its mate, No. 6, is therefore adopted.

Brown into Manchuria, using the same circle and needles Nos. 2 and 5 but replacing Nos. 1 and 6 by two others. The corrections on adopted standard for the needles used during both expeditions for inclination +62°.2 were: in Mongolia during September and December 1915, +0′.6 for No. 2 and +5′.2 for No. 5; in Manchuria during September 1916, +0′.4 for No. 2 and +0′.2 for No. 5. The corrections for September and December 1915 are taken from the curves adopted from the consideration of a large number of stations, while those for Manchuria are from an analysis based on two stations, these being the only ones at which observations were made at inclination values suitable for comparison. The large correction for needle No. 5 which was obtained for the Mongolian observations applied equally well in September and December 1915, but no evidence for the necessity of such a large correction could be found from the observations in September 1916, indicating that, whatever the cause might have been, it persisted for a few months only.

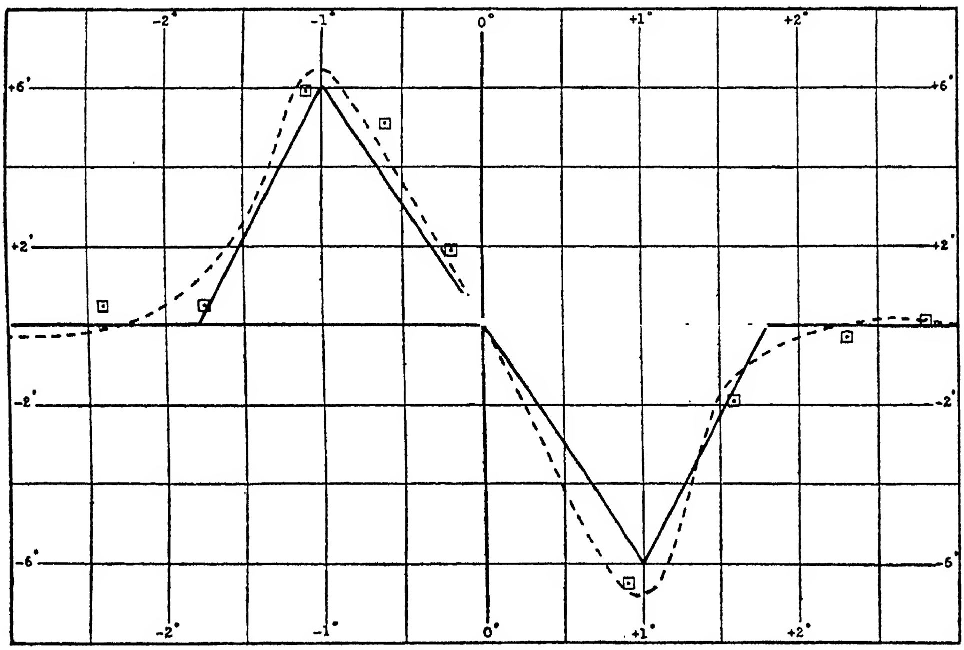


FIG. 10.—Observed and Computed Correction-Curves for Needle No. 5 of Circle No. 177.

One further cause for the erratic behavior of needles has recently come to our attention. Dip circle No. 177, which has been a superior instrument, was equipped with four new needles for use in the campaign of 1919 to 1920 through central Africa. These needles gave results which differed among themselves by unusually large amounts, despite the observer's conscientious efforts to bring them into harmony by careful attention to the pivots and repeated readings, indicating minute pivot-defects. Needle No. 16X, as the work progressed, showed most unusual and erratic behavior; it was ultimately discovered by the observer that the pivot of this needle had become so loose in its sheath that it could be easily withdrawn. Obviously cleaning such a loose pivot by a rotary motion in pith, tissue paper, or chamois, as is the practice, might rotate it slightly, thus altering the balance of the needle and causing considerable variations in the results. It is not supposed that such conditions have often occurred, but they may be responsible for some difficulties otherwise impossible to explain. In this case it may have been due in part to extreme daily range in temperature, expanding unequally the steel pivot and its brass sheath.

CONCLUSIONS.

1. In order to furnish the data required for a proper elimination of results affected by imperfect pivots, not less than four needles should be used at each station.

2. An inconsistent value by a given needle at any station does not necessarily imply that the needle will not behave satisfactorily at another station where the inclination is slightly different.

3. Although the correction for a needle may remain indefinitely constant at a given value of inclination, it is not safe to assume that it will certainly do so, on account of the possibility that minute defects on the pivots may appear during the progress of work; such defects are not necessarily permanent, for if they are rust masses, they may possibly be removed by friction with the material used for cleaning.

4. The stability of a needle when disturbed by a defect on the pivot depends on the condition that the coefficient $\frac{A}{F-A}$, shall be positive and as small as possible, where F is the total force and A is the needle-constant $\frac{wgr}{m}$. Since this constant for ordinary Dover needles has a range of values not far different from the range in F, needles for work in a given region should be carefully selected.

5. From comparison observations at a base-station and without a knowledge of the behavior of a needle in adjacent regions, it is not possible to decide whether an unusual result may be caused by a pivot defect; nor has any practical method been found whereby the existence and position of these defects may be determined, other than by actual field observations.

6. Since the magnitude of pivot defects may vary from comparatively large ones as studied in this discussion to others indefinitely smaller, and since the distribution of field stations can not always be sufficient to reveal the possible existence of such defects, the weakness of the dip circle as an instrument of high precision is apparent.

A SINE GALVANOMETER FOR DETERMINING IN ABSOLUTE MEASURE THE HORIZONTAL INTENSITY OF THE EARTH'S MAGNETIC FIELD.

By S. J. Barnett.

1. Magnetometer methods devised by Gauss, Weber, and Lamont in the first half of the last century, and brought to a high state of perfection through the labors of many others, have long made it possible to measure the horizontal intensity of the Earth's magnetic field with considerable precision. By comparing with this intensity the intensity due to a coil of wire traversed by an electric current, the current can be determined in electromagnetic units, provided that proportionality exists between the current in the coil and the intensity of its field, and that the ratio of the two can be calculated from the fundamental theory.

Many absolute determinations of electric currents have been made in this way, but it has in comparatively recent years become possible to make independent determinations of current with much greater precision and facility than that with which it is possible to measure the horizontal intensity of the Earth's field with magnetometers. Hence many students of the Earth's magnetism have considered making use of the same comparison to determine this intensity in terms of an electric current.

Probably the simplest instruments by which this comparison of intensities can be made are sine and tangent galvanometers, whose prototypes were introduced by Pouillet in 1837[1], and either one of which can be constructed in such a way as to satisfy all necessary requirements. Of the two instruments, when so constructed, the sine galvanometer is somewhat the simpler, can be made the more sensitive, and has been preferred by at least most of those who have considered this subject.

2. The essential parts of a sine galvanometer are a simple magnetometer, a divided circle, and a coil of insulated wire producing a magnetic field preferably symmetrical about an axis, together with their adjuncts.

In the ideal instrument the circle is mounted with its axis vertical and coincident with that of the suspension of the magnetometer magnet; and the axis of symmetry of the coil, which is then horizontal, passes through the axis of the circle and the center of the magnet. Both magnetometer and coil can be rotated together about the vertical axis of the circle. All materials except the magnet must have magnetic susceptibilities differing by negligible amounts from that of air.

If the axis of the coil is initially in the magnetic prime vertical and that of the magnet in the magnetic meridian, and if a suitable current J is passed through the coil, producing throughout the region occupied by the magnet a magnetic intensity GJ along the coil's axis, the magnet (and mirror or lens) will be deflected through an angle ψ such that

$$\tan \psi = \frac{G\,J}{H} \tag{1}$$

where H is the horizontal component of the intensity of the Earth's magnetic field. But it can be brought back to its initial position relative to the coil by turning the latter, in the direction of the magnet's motion, through an angle θ, such that

$$\sin \theta = \frac{G\,J}{H} = \tan \psi \tag{2}$$

[1] Comptes Rendus, vol. 4, 1837, p. 267.

Thus if G, J, and θ are known, H can be calculated from the equation

$$H = \frac{GJ}{\sin\,\theta} \tag{3}$$

If the constant G can be calculated from direct linear measurements upon the coil, the instrument is known as an absolute instrument.

3. If the construction is such that $\tan\psi$ can be measured, the coil remaining fixed, the instrument becomes a *tangent galvanometer*. In all instruments of this kind with which I am acquainted, the magnetometer remains fixed like the coil, and the deflection of the magnet and mirror cannot be read, as in the sine galvanometer, with a precision circle. Moreover, the torsion of the fiber which supports the magnet is different in the initial and final positions, since the magnet moves with respect to the magnetometer box. But if the magnetometer (including the reading devices, such as telescope and scale) is constructed to move over a divided circle, and the scale reading is made the same in the initial and final positions, as in the sine galvanometer, both disadvantages (the first not of great importance) are removed and the instrument becomes capable of precise measurements.

Another, but less flexible, method of rendering a tangent galvanometer precise consists merely in the substitution of a multiple-faced mirror with fixed angles between the faces for one with a single face, and has recently been proposed by W. A. Jenkins[1]. With this device any mirror sine galvanometer can be transformed into a tangent galvanometer, but the torsion of the fiber is not eliminated.

4. Returning to the sine galvanometer, and differentiating (3) logarithmically, we find that the error $\Delta H/H$ in determining H arising from the errors in determining G, J, and θ is given by the equation

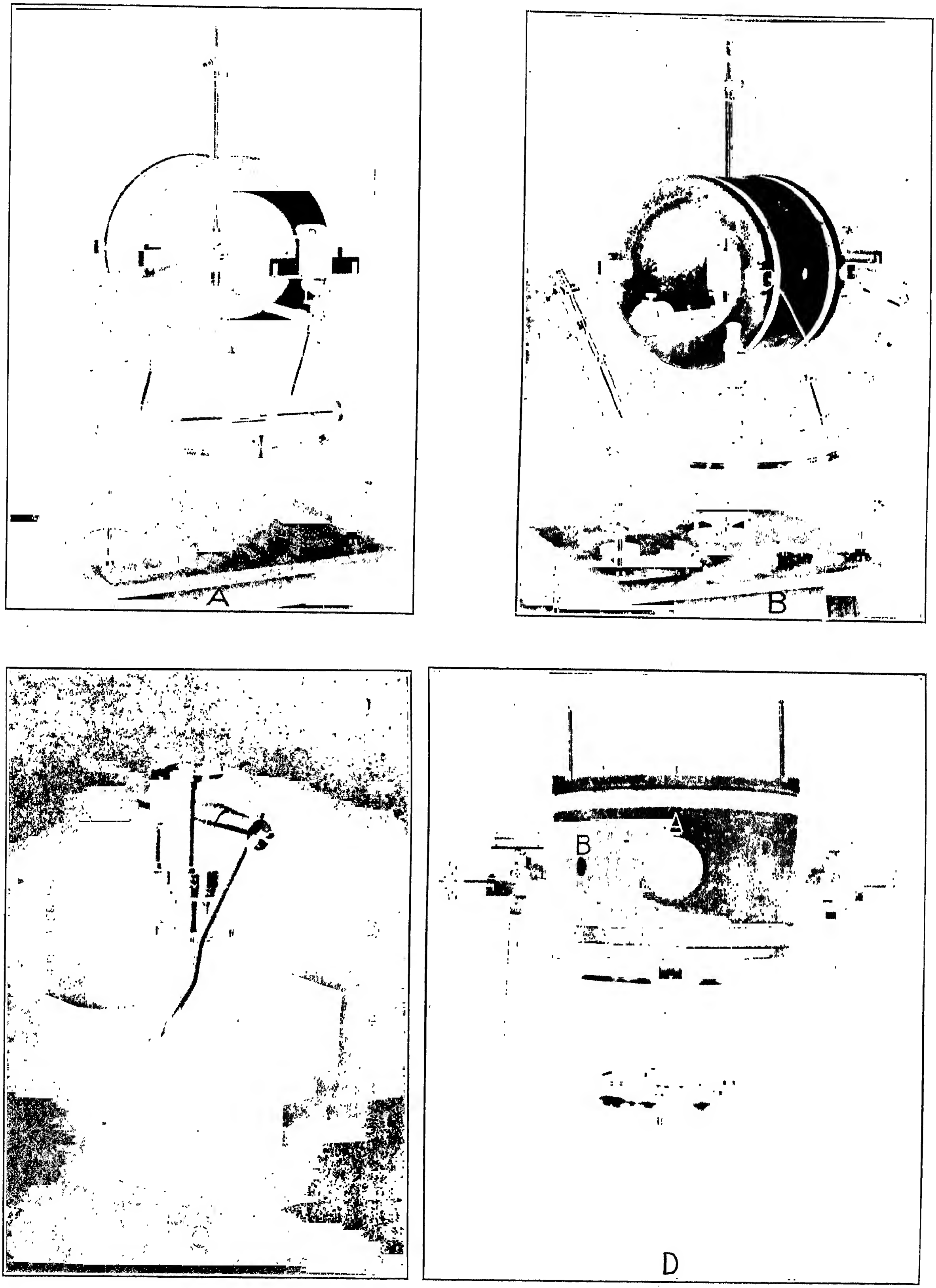
$$\frac{\Delta H}{H} = \frac{\Delta G}{G} + \frac{\Delta J}{J} - \cot\,\theta \cdot \Delta\theta \tag{4}$$

It has long been possible to determine an angle and its sine, and it has more recently, within the last thirty years, become possible to determine an electric current, with great precision and facility. At the same time, by using the method of winding a coil in a single layer in spirally cut grooves on a cylindrical surface, as first suggested by J. Viriamu Jones[2], it has become possible to construct a coil whose constant G can be calculated with great precision.

It has thus become possible, as we shall see, to construct a sine galvanometer by which H can be measured with all the precision which is desirable, in view of its known fluctuations, and with a rapidity far greater than that which is possible with the magnetometer method.

5. The first sine galvanometer of precision designed for absolute measurements of magnetic intensity was described by W. Watson in 1902[3]. It was made simply by adding a pair of large and carefully constructed Helmholtz coils to a Kew magnetometer, and rendered excellent service in spite of its somewhat cumbersome character. A new and complete instrument, with a single coil, and of much smaller dimensions than Watson's, was designed for the same purpose in 1912 by N. E. Dorsey, while a Research Associate in the Department of Terrestrial Magnetism; but the instrument was never constructed, and no account of it has been published[4]. In 1914[5] Schuster published a preliminary

[1] Phil. Mag. (6), Vol. 41, 1921, p. 454.
[2] Roy. Soc. Proc. vol. 63, 1898, p. 204.
[3] Phil. Trans. A., vol. 198, 1902, p. 431.
[4] I have had the advantage of reading Dr. Dorsey's MS. For a brief reference, see C. I. W. Yearbook, No. 13, 1914, p. 322.
[5] Terr. Mag. vol. 19, 1914, p. 19.



SINE GALVANOMETER.

A and B. Views of the new instrument.
C. Magnetometer box, supports for box and spool, and device to insure correct turning and orientation.
D. Spool, complete with coils, in machine for measuring diameters.

account of a new instrument, essentially a sine galvanometer for use at large angles, but apparently with the magnetometer fixed to the tripod. This instrument has since been completed by Schuster and F. E. Smith at the National Physical Laboratory of England, but the description of it has not yet been published. A paper on this subject has recently been published by W. Uljanin[1], but the absolute instrument he has designed has not yet been constructed. A sine galvanometer designed especially for field determinations of the horizontal intensity was described and used in 1920 by N. Watanabe.[2]

6. The essential parts of the design of the instrument now to be described, which is intended for use in the Standardizing Magnetic Observatory of this Department, were completed in 1918, but its construction was not completed until the present year. Photographs of the instrument are given in Figures A and B of Plate 9. It is marked D.T.M. C.I.W. Sine Galvanometer No. 1.

The base of the instrument, including the tripod, circles, reading microscopes, etc. was originally part of one of Wild's large unifilar theodolites of the latest pattern designed for the determination of the horizontal intensity, and was made by Edelmann; but it was modified in the Department's instrument-shop in three ways. In the first place, a number of the parts, which were found to be magnetic, were replaced by duplicates of carefully tested non-magnetic material. In the second place, the mirrors designed to illuminate the precision circle were removed and replaced by small, 4-volt, 1.2-watt electric lamps in ventilated screening tubes, and the plain glass in the windows beneath them was replaced by milk glass. This has made it possible to set the microscopes with much greater facility and with far less error than formerly, as the illumination is now always excellent and is independent of the azimuth. In the third place, two half-minute levels were mounted at right angles on the rotating table.

The instrument has two horizontal circles mounted rigidly together with corresponding divisions in the same azimuth and movable together about the same vertical axis. The outer, or rough, circle is uncovered and is divided into intervals of 1°. The inner or precision circle is covered by the table which carries the microscopes, the magnetometer, etc. Independent clamps are, of course, provided for the circle and the table, and a tangent screw for the latter.

The precision circle is 30 cm. in diameter and is divided into intervals of 10′. Two filar micrometer microscopes, set 180° apart, make it readable to less than 2″, corresponding to one division on the micrometer heads. In addition to the micrometer microscopes, and on account of their small fields, a third microscope, or finder, covering more than 1°, is provided, so that the circle can always be read with convenience and certainty in any position. The accuracy of the divisions of the precision circle was tested by measuring an angle of about 5° in each interval of 10°, and no error in the total angle as great as 4″ was found. The maximum error of division was thus found to be about 2″; the mean error was about 0.6″. The eccentric angle was found to be about 30″.

The insulating material used in mounting the lamp sockets and terminals is pyralin. The globes themselves were specially made of non-magnetic material by the National Lamp Works of the General Electric Co. The lamps are shown in Figures A and B of Plate 9 at the bases of the microscopes.

7. The magnetometer is exceedingly simple in design. The box has the shape shown in Figures A, B, and C of Plate 9, and was cut from a solid block of copper cast in the foundry of this Department by Mr. C. Huff. It is so free from iron as to be diamagnetic. The box is symmetrical about the vertical axis and has two plane faces 4.5 cm. apart. A circular cylindrical hole 2.3 cm. in diameter pierces the box centrally at right angles to these faces and forms the chamber in which the magnet hangs. Glass windows carried by

[1] Terr. Mag. vol. 24, 1919, p. 118. [2] Proc. Phys. Math. Soc. Japan (3), vol. 2, 1920, p. 210.

short brass tubes, one of them shown in Figures A and B, close the holes, except when, at will, one of them is replaced by a copper plug, as in Figure B, to increase the damping; or when the other is replaced by a plane glass mirror, carried normal to its axis by a longer brass tube, to assist in adjusting the telescope; or during alignment tests with the devices shown in Figure C and at the bottom of Figures A and B. An axial (vertical) hole 6 mm. in diameter, flaring at the ends, passes through the upper part of the box to admit the suspension. A second horizontal cylindrical hole 3 mm. in diameter passes through the box with its axis intersecting those of the other holes at right angles. Its outer ends are closed by glass windows and its object is to permit sighting along the axis of the magnet.

The magnets are circular discs of steel polished on both sides, which serve as mirrors, and magnetized in an intense field directed along a diameter. Two magnets have been used. One, made in the instrument shop by Mr. Steiner, is a disc of tungsten steel 20 mm. in diameter and less than 1 mm. thick, provided with small holes near opposite ends of the same diameter normal to the magnetic axis, so that the magnet can be suspended from either end of this diameter in order to determine the angle between the face of the mirror and the magnetic axis. This angle for the face used is about 6′.

The other magnet is one of the gages 20 mm. in diameter and 1 mm. thick made from chrome steel and polished on both sides by the Bureau of Standards, to which we are indebted for it. The surfaces are flat within a fraction of a wave length of sodium light, and they are parallel within about 1″. The angle between the surfaces of the magnet and its magnetic axis is less than 2′. This magnet was not pierced with holes like the other, but was provided with a small closely fitting saddle of brass, illustrated in Figure 11, by which it can readily be suspended with the magnetic axis in any altitude. The altitude can be altered at will by simply slipping the saddle along the periphery of the magnet, care being taken to push it in radially at the same time.

The torsion tube, head, and rod are similar to those on the C. I. W. magnetometers, except that the rod ends below in a small vertical ring for attaching the suspension. A flange at the bottom of the tube is screwed to the top of the copper box, proper arrangements being made for automatic centering. The rod is provided with rack-and-pinion vertical adjustment. The head is provided with a clamp, and is divided into intervals of 10°.

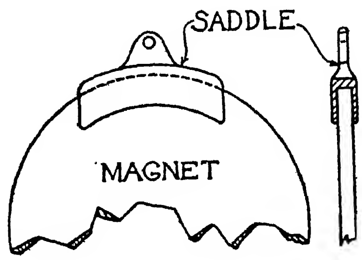


FIG. 11.—Magnet-Mirror Holder.

Suspensions of single silk fiber, Wollaston wire, and fine phosphor-bronze strip have been used. They may vary from about 18.5 cm. to about 26.5 cm. in length. The bronze strip is especially satisfactory. In addition to other advantages, a metallic suspension has the advantage over silk and quartz of eliminating possible troubles from electrification. Small right-angled geometric hooks are soldered to the ends of the metallic suspensions for holding the magnet and for attachment to the torsion rod. The torsional constant is far too small to be troublesome with any of the suspensions and magnets used.

The magnetometer box is screwed on to the top of a brass piece A, Figure C, whose central portion B is a circular cylinder and carries the arm holding the telescope and scale. The lowest part L of A is also cylindrical and coaxial with B, but of smaller diameter. L projects through and is screwed to a circular flange C, which fits centrally over a similar flange D forming the top of the brass support DE. The cylinder L just fits a central hole in the top of DE. The two flanges are clamped together with four screws, circular slots in the upper one permitting a little motion in azimuth for adjustment. The support DE is bolted centrally to the saddle F, which carries the marble core on which the coils are wound. The upper portion of this saddle was turned with a fly cutter to the

proper diameter, tests being made with the arrangement H shown in Figure C. This is not the most precise method by which this work could be done, but it was quite adequate for the purpose. The workmanship was such that the center of the magnetometer and the center of the coil system coincided within a fraction of a millimeter, while the axis of the spool and the plane containing the coil terminals were very nearly perpendicular to the (vertical) axis of the magnetometer. The saddle was screwed to the top of another machined brass casting G, provided with two coaxial circles, one fitting over a central circular ring integral with the axle or "center" of the turn-table, and the other fitting over a central circular disc projecting from the bottom of the saddle. The machine work was such that when the turn-table was leveled the magnet hung with its center within a fraction of a millimeter of the center of the magnetometer box.

The telescope, the scale, and a small electric lamp to illuminate it, together with a shade not shown in Figures A and B, are carried on a vertical brass rod clamped, with vertical sliding adjustment possible, to a horizontal tube which slides in a second tube with a clamp at the end. This tube and a third tube, which carries a counterpoise, are soldered into a ring by which and a screw they are clamped to the support AB, Figure C.[1]

The scale, 10 cm. long and of white pyralin, is divided to thirds, sixths, and thirtieths of a centimeter. The scale distance can be varied over a range of about 10 cm. from about 34 cm. up. With the telescope used, which is small but has excellent definition and high magnifying power, and either of the steel mirrors, the scale can be read easily to tenths of the smallest divisions. In addition to the adjustments already mentioned, the telescope is provided with fine adjustments in altitude and azimuth, and the scale can be moved laterally a small distance in its support. The scale divisions are so numbered that the readings increase continuously with clockwise rotation of the mirror, just as the circle readings increase continuously with clockwise rotation of the magnetometer and coil.

8. The great importance of securing a uniform field, and one whose intensity can be calculated with precision, throughout the region in which the magnet is ever placed for measurements, whether in or out of perfect adjustment, led to the adoption of the type of double coil introduced in 1849 by Helmholtz[2], and to its being wound from bare copper wire under tension in a single layer in lathe-cut spirals, as suggested by Jones. For the same reason white Carrara marble, already used with satisfactory results for the cores of many coils of precision, notably at the National Physical Laboratory of England, was chosen for the spool. This substance has a permeability differing from unity by a negligible amount. Moreover, after being subjected to a preliminary heat treatment its dimensions remain practically unchanged with time and their thermal changes are reversible for small temperature ranges[3]. At the same time its electrical resistivity is very high, especially when impregnated with paraffin.

In order to make it possible to test the insulation of the coils at any time, each coil of the Helmholtz pair was wound in two halves, each consisting of a spiral of the same length and pitch. The two spirals starting from the same plane normal to the axis 180° apart. The spirals of one Helmholtz coil were designated as Nos. 1 and 2; those of the other as Nos. 3 and 4.

This method of winding Jones spirals is due to Ayrton[4], and has, in addition to the facility it affords for making satisfactory insulation tests, the further advantage, appar-

[1] The telescope and the telescope-and-scale holder were taken froma nother instrument, non-magnetic parts being substituted for magnetic parts in the holder. The original design called for the simpler type, with telescope and scale fixed rigidly together and double clamp to the central rod as used in Kohlrausch's universal magnetometer, which has some advantages.

[2] See Wiedemann's Elektrizität, vol. III, p. 275.

[3] See Souder and Hindert, Scientific Papers, Bureau of Standards, No. 352, Dec. 1919.

[4] Jour. Inst. Elec. Eng., vol. 35, p. 18.

ently not hitherto pointed out, that it makes the mean intensity along any straight line normal to and bisected by an axial plane through or half way between the terminals of the double spiral zero, as follows from considerations of symmetry and Maxwell's relation between the current and the integral of the magnetic intensity in a closed path around it. If this mean intensity in the horizontal direction were not zero, no error would be introduced except a possible minute error due to a change in the angle between the axis of the magnet and the surface of the mirror which it might bring about—as might also the variation of the component of the horizontal intensity of the Earth's field parallel to the magnet's axis brought about by its motion.

It was originally planned to wind one pair of spirals left-handed and the other right-handed, but both were wound in the same direction on account of the increased facility and precision with which this could be done. In view of the remarks made in the last paragraph there seems no advantage to be gained by the more troublesome arrangement.

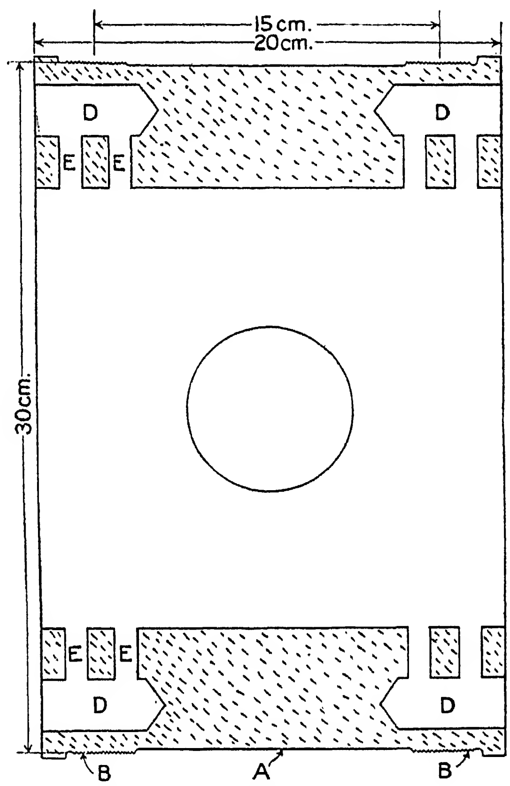


FIG. 12.—Horizontal Section of Spool.

9. Through the kindness of Messrs. S. Klaber and Co. of New York City, two pieces of Carrara marble were selected in Italy by a representative of the firm and worked up there into rough spools of the approximate dimensions needed. When both had been turned in the instrument shop sufficiently to make a more satisfactory examination possible, it was difficult to say that one was superior to the other. Neither piece was entirely homogenous, but both were free from pronounced veins, and the black specks of iron pyrites, said often to be present in Carrara marble, were almost entirely missing. One of the pieces was chosen and was carefully machined to nearly its final form. It was then heated slowly in a gas furnace to the approximate temperature of boiling paraffin, 250° F., and was kept at this temperature for forty hours. It was then inserted into a mass of pure paraffin previously heated to the temperature 230° F., and the vessel containing both was then put in the furnace and kept there for another forty hours at temperatures between 230° F. and 240° F. The cylinder was then quickly removed from the paraffin and cooled slowly to room temperature in the furnace over a period of about 30 hours.

The large holes (67 mm. diameter), with axis vertical in the mounted instrument, Figures A and B, provide for the insertion of the magnetometer, as well as for holding the end standards used in the measurement of the diameters. The other and smaller holes (20 mm. in diameter), with axes in the mean plane of the central cylinder, also serve the latter purpose, the two in the central horizontal plane, Figures A and B, serving in addition as sight holes. Any of the smaller holes may also be used to hold a thermometer. The holes in the horizontal and vertical axial planes were drilled before the final turning of the grooves, etc., the latter pair serving as guides in doing the machine work for the precise location of the spool and coils.

The spool was first carefully turned on the face-plate of the lathe to the approximate dimensions indicated in Figure 12. Both the large holes, and the 20 mm. holes with axes

horizontal, were then located precisely and cut out on a Brown and Sharpe universal milling machine. The spool was then given the thermal treatment with paraffin already described, after which the remainder of the machine work was done.

For the final turning of the cylinder *B*, in which the grooves were to be cut, and the cylinder *A*, by which the spool was to be mounted on the turn table, the spool was mounted on a specially constructed mandrel, a diagram of which is given in Figure 13.

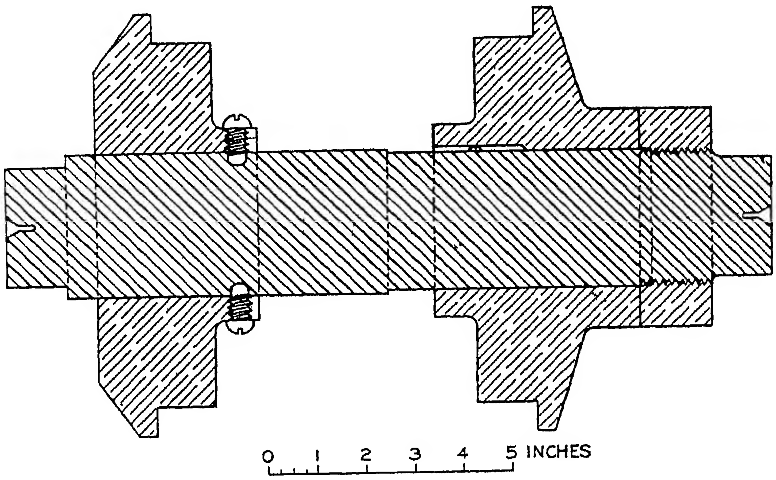


FIG. 13.—Horizontal Section of Mandrel used in Precise Turning of Spool.

The cylinders *A* and *B* were turned with a fragment of diamond which happened to be on hand. An attempt was made to do all but the final part of the work of cutting the spiral grooves with a tool of hardened steel; but the marble threads broke out so badly, in spite of great care, that this work had to be done over again with a special diamond tool. This diamond tool, obtained for the final work on the grooves, had an angle of 84°, and has given excellent satisfaction.

To turn the groove for one of the coils, the spool on the mandrel was so adjusted in the lathe that the spiral would have the exact relation to the spool called for by the design, and the groove cut to about one-half its final depth. Then the groove of the same spiral near the other end of the spool was cut to about half its final depth. The two grooves, part of the same spiral with 2 mm. pitch, were then gradually cut down almost to their final depth. Then the mandrel, with the dog and the spool, was turned through exactly 180° with respect to the face-plate, and the grooves for the second spiral were cut in the same manner almost to their final depth. All the spirals are right-handed.

The last cut of the two grooves forming each spiral was taken with the same setting of the tool and with the screw in continuous operation. For the second spiral, the dog and mandrel had, of course, to be turned, as above, through 180°, and the tool had to be reset.

When the grooves, which extended over somewhat larger areas than were to be occupied by the wires, had been cut, the spool was mounted on a Brown and Sharpe universal milling machine and the eight radial cylindrical holes opposite *EE*, Figure 14, drilled precisely at the centers of the proper grooves in the axial plane which was to be horizontal in the completed instrument. The holes were drilled with a diameter 1.17 mm. considerably larger than that of the wire, as the use of a drill with the small diameter of the wire would have endangered the precision and would have introduced the serious risk of the drill's being broken off inside the marble. The inner half of each hole was then counterbored and threaded to receive a threaded brass plug 2.38 mm. in

outside diameter with an axial hole 0.61 mm. in diameter. A cylinder of pyralin with slightly greater diameter than 1.17 mm., and traversed by an axial hole 0.61 mm. in diameter, was driven into the outer half of each hole. The four brass plugs nearer the equatorial plane of the spool extended about 2 mm. into the holes *D*, the outer half of each cylinder being removed from the extending portion. The holes *EE* were drilled with a specially constructed right-angled drill, and enabled the counterboring, threading, etc., to be done with facility.

10. The wire for the coils was prepared and presented to the Department with great kindness by the Research Laboratory of the General Electric Co. through the courtesy of Dr. W. R. Whitney. Hard drawn copper wire about 0.76 mm. in diameter had its diameter reduced to about 0.71 mm. by solution in nitric acid, to remove the surface

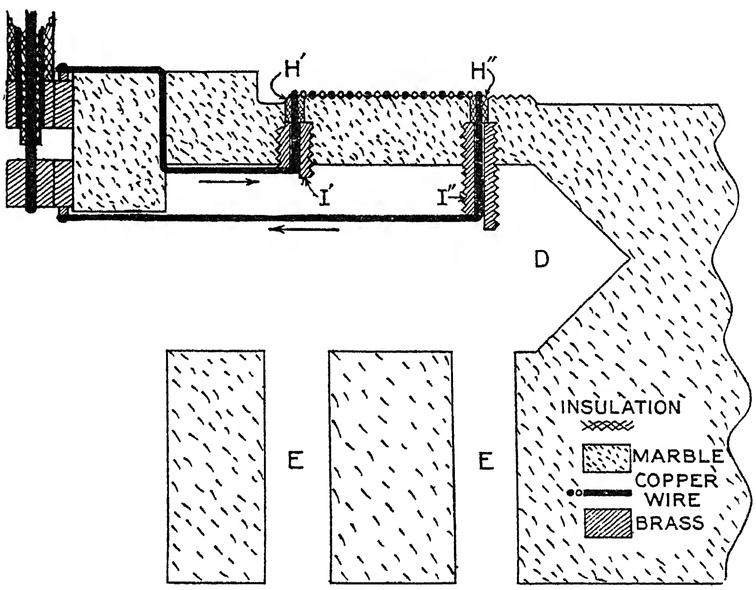


FIG 14 —Horizontal Section of one Pair of Terminals.

which might have been contaminated by iron from dies used in previous operations This wire was then drawn through a series of circular diamond dies until an exceedingly uniform diameter about 0.576 mm. was attained, and was wound directly from the dies onto a spool 30 cm. in diameter.

Before beginning to wind a coil, one end of the wire was annealed, to make possible the rather sharp bends near the terminal, and was then pushed through the inner pyralin bushing H'' and the brass plug I'' and brought out through the hole *D*, Figure 14 It was then soldered (with dissolved rosin as flux) securely and axially to the projecting end of the plug. The wire was then slowly wound on the groove under a uniform tension of about 4 kg. until the second terminal was nearly reached. It was then clamped several centimeters from the terminal and cut off at a suitable point. The end was then annealed and pushed through the bushings H' and I' and drawn through *D*. The end was then pulled tightly until the wire lay in its groove between the clamp and the terminal and the wire was soldered to the bottom of the plug I' while bent close to the marble surface. The clamp was then removed and the wire sprang more accurately into its place in the groove. All of the coils were wound in this manner. After preliminary micrometer measurements, a successful effort was made to reduce small irregularities occurring close to the terminals of the windings by tapping with a light hammer and small ebonite block.

11. The shape of the terminals, the nature of the insulation, and the method of connection to the ends of the coils and the concentric or coaxial cables which formed the leads to the battery and measuring devices are shown in Figure 14. Each of the terminal loops was made as nearly like the others as practicable, and each lies in the axial horizontal plane. The intensity each produces in this plane is thus vertical. Moreover, at all points along the axial vertical plane the vertical intensities of the loops neutralize one another in pairs. The marble insulators, carrying the brass terminal blocks, were treated with hot paraffin, but not just like the spool. The cables were specially made from stranded and braided copper wire, with cotton and rubber insulation, by the Belden Mfg. Co., and their ends were carefully tinned before being soldered to the terminals. They were left about 35 ft. long each, the conductors of each cable, equivalent to Nos. 21 and 22 wire, B. and S. gage, being soldered to a double binding-post on a block of ebonite.[1]

The marble spool was mounted as shown in Figures A and B in the brass saddle already described and was held in position by four brass screws coming up vertically through the saddle from beneath.

In much of the work on the marble spools, coils, etc., we have profited greatly by the experience gained at the National Physical Laboratory.[2]

12. The ideal Helmholtz coil consists of two equal coaxial circular turns of linear wire, the axial distance between whose planes is equal to half their diameter. The magnetic field near the center of such a system of two circles traversed by the same electric current in the same direction is very nearly uniform. If, as is approximately the case in the coils of the instrument described here, the diameter is 30 cm., the axial intensity at a point on the axis $\pm$ 0.5 cm. from the center does not differ from that at the center by as much as 1 part in 400,000. Even for a distance of 1 cm. the difference is less than 1 part in 42,000 (§13).

If, therefore, we substitute for each circle in the ideal Helmholtz pair, 30 cm. in diameter, any number n of circles of the same diameter distributed axially over a range even as great as 2 cm., the axial distance between corresponding circles in the two groups being always 15 cm., each of these pairs will produce at the center of the system the same axial intensity as that due to a central pair within less than 1 part in 42,000. If the circles in each group are uniformly distributed, the intensity at the center of the system will be n times that due to a central pair within much less than 1 part in 80,000.

Furthermore, it is clear from what precedes and the general form of Ampère's expression for the magnetic intensity due to a current element, that any circle of a 30 cm. coil may be distorted by a purely axial displacement of any part or parts, provided that this displacement does not make the extreme width of the group to which it belongs greater than 2 cm. and that the corresponding part of the other group is distorted in exactly the same way, without affecting the axial intensity at the center by as much as the small quantities mentioned above. Either group, moreover, or a distortion in either group, may evidently be displaced angularly about the axis without affecting the axial intensity at the center at all.

As a special case, the two groups forming a Helmholtz pair 30 cm. in diameter may be wound in equal regular helices as much as 2 cm. in axial length, the axial distance between corresponding points on the two helices being 15 cm., and yet the axial intensity at the center may be calculated with an error less than 1 part in 84,000 on the assumption that each pair of spiral turns produces at the center of the system the same axial intensity as the ideal 30 cm. Helmholtz pair produces at its center.[3]

[1] These cables have given entire satisfaction only when the portions which move when the coil is turned in azimuth have been hung from above approximately vertical. Otherwise the change of resistance due to the distortion produced by the motion affects the current more than is admissable.

[2] Ayrton, Mather, and Smith, Phil. Trans. A, vol. 207, 1908, p. 463; and F. E. Smith, Ibid., vol. 214, 1914, p. 27.

[3] With regard to the equivalence of circular current sheets and spirals for the axial intensity at points on the axis in the general case, see J. V. Jones, Roy. Soc. Proc. vol. 63, 1898, p. 204.

As will be seen below, the Helmholtz relation *diameter = twice axial distance* is not exactly satisfied for the spirals of the instrument described here. For our case, if we assume the spirals uniform and exactly alike, with diameter and axial distance equal to the mean diameter and axial distance, it happens that the axial intensity at the center may be calculated as n times that of the central pair with an error less than 1 part in 800,000. These conditions are, of course, not exactly realized, but in any case the error is quite negligible.

Furthermore, it has been shown by Lyle,[1] Rosa,[2] Searle,[3] and others that a circular or helical turn of round wire whose diameter is small in comparison with that of the turn, produces very nearly the same magnetic intensity at points remote from it as if the current flowed through a linear turn coincident with the axis of the wire, and this whether the current density is uniform over the cross-section of the wire, or inversely proportional to the distance from the axis of the turn. For the central part of the field of a pair of coils such as we are concerned with here the approximation is exact to about 1 part in 2×10^6.

13. In order to calculate the constant G of the spiral coils used in this work, therefore, it is necessary only to know the mean diameter $d = 2a$ of the spirals and the mean axial distance $x = 2z$ between the corresponding parts of the two groups of spirals, to apply the standard formula for the axial intensity at the center of a system of two equal coaxial circles, traversed by unit current, with the Helmholtz relation very nearly satisfied, and to multiply by the number $N/2$ of turns in each spiral. Thus we have

$$G = \frac{2\pi a^2 N}{(a^2+z^2)^{3/2}} = \frac{4\pi d^2 N}{(d^2+x^2)^{3/2}} \tag{5}$$

In order to show that the field within which the magnetometer magnet is capable of being placed while the instrument is being used is nearly enough uniform, we shall assume at first a system of two coaxial circles.

The axial intensity per unit current due to a single circle of radius a at a point distant y from the axis and z from the plane, or $r = (a^2 + z^2)^{1/2}$ from the circle, is known to be[4]

$$f = \frac{2\pi a^2}{r^3}\left\{1 + \frac{3y^2}{4r^4}(a^2-4z^2) + \frac{45}{64}\frac{y^4}{r^8}(a^4 + 8z^4 - 12a^2z^2) \ldots\right\} \tag{6}$$

First assume a true Helmholtz pair with diameter 30 cm. To find the fractional diminution of the intensity in moving 1 cm. along the axis ($y = 0$) from the center, we may calculate f for $z = 7.5 + 1$ and for $z = 7.5 - 1$, add, subtract the sum from $2f$ calculated for $z = 7.5$, and divide the result by the last quantity. We thus obtain about 10 parts in 424,000. Similarly, for distances of 0.5 cm., 1.1 cm., 1.2 cm., and 1.5 cm., we obtain 2, 14, 20, and 48 parts, respectively, in 424,000.

Next assume the circles have the mean radius and axial distance for the actual spirals, viz, 14.9518 cm. and 14.9966 cm., as obtained from Tables I and II below. Proceeding as above, we find for distances 0.5 cm. and 1.0 cm. fractional diminutions not greater than about 1 part in 427,000. For distances 1.1 cm., 1.2 cm., and 1.5 cm., the fractional diminutions are 2, 5, and 27 parts in 427,000.

From these data it is easy to see that the axial variation of the axial intensity in the case of our spirals is entirely negligible, whether we assume the actual mean linear dimensions or the approximately correct Helmholtz dimensions given above.

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[1] Phil. Mag. (6), vol 3, 1902, p 310.
[2] Bulletin of the Bureau of Standards, vol. 2, 1906, p. 71; and vol 3, 1907, p 209
[3] With Ayrton, Mather, and Smith, Phil Trans. A. vol 207, 1908, p. 541
[4] See Gray's Absolute Measurements, vol II, p. 248

Thus in the first case assume the spirals displaced axially 2 mm., which is far in excess of the displacement from the center which the magnet can ever have. No effect, to 1 part in 427,000, will come from the displacement of those spirals which remain between the planes distant $\pm$ (7.5 $\pm$ 1) cm. from the center of the magnet. Of the two remaining pairs of turns, the effect of one will be reduced 1 or 2 parts in 427,000, that of the other 4 or 5 parts in 427,000.

If we assume the Helmholtz dimensions, with $a = 15$ cm., none of the spirals but the two pairs last considered will have their contributions at the magnet modified by as much as 10 (or even 5) parts in 424,000. Of these two, the contribution of one will be reduced by about 4 parts in 424,000; the contribution of the other will be reduced by about 10 parts in 424,000.

In the first case the total reduction of the intensity at the magnet is not more than 1 part in 400,000; in the second, 1 part in 80,000.

To calculate the fractional variation of the axial intensity in the central plane normal to the axis for the pair of circles we have only to evaluate the second and third terms within the braces of equation (6). If we write $f_0 = \dfrac{2\pi a^2}{r^3}$, give a and z the mean values obtaining for our coil, and express y in mm., the equation becomes approximately

$$f = f_0\,(1 - 13 \times 10^{-8}\,y^2 - 8\,7 \times 10^{-10}y^4 \ldots) \qquad (7a)$$

The first correction-term in equation (6), however, which is strictly zero for a true Helmholtz pair, varies greatly with the axial distance $2z$. Hence, as our spirals are 2 cm. wide, it is desirable to obtain a closer approximation. For this purpose we may use the method of Lyle (1.c. *ante*) and consider each complete spiral replaced by two circles of the same radius, a, symmetrical about the mean plane and distant β therefrom—where β^2 is $1/3 \cdot (\alpha^2 - \rho^2)$, 2α is the length of the spiral, viz, 2 cm., and 2ρ is the diameter of the wire, viz, 0.58 mm., and each circle carries the current of half the turns of the actual spiral. Applying the formula (6) to the inner and outer pair of these Lyle circles, and properly combining the results, we get in place of (7*a*) the much more nearly true equation

$$f = f_0\,(1 + 10 \times 10^{-8}\,y^2 - 8.5 \times 10^{-10}\,y^4 \quad . \quad . \quad . \quad . \quad .) \qquad (7b)$$

No part of the magnet, when in proper adjustment, extends more than 10 mm. from the center. At a distance of 11 mm. from the center (7*a*) gives $(f - f_0)/f_0 = -2.8 \times 10^{-5}$, while the much more nearly correct formula (7*b*) gives $(f - f_0)/f_0 = -0.4 \times 10^{-6}$. On account of the construction no part of the magnet can ever be more than 11.5 cm. from the center; and there is no occasion in practice for 11 mm. to be reached. Thus $(f - f_0)/f_0$ will always be entirely negligible.

14. The method of measuring the overall diameters of the spirals resembles, to a considerable extent, the methods used in the National Physical Laboratory of England by Ayrton, Mather, and F. E. Smith[1]. It is illustrated in Figure D of Plate 9. The spool was mounted with its axis vertical and central on the adjustable leveling table in the instrument testing room, and could thus be moved axially through any distance required without rotation. The spool was so mounted, however, as to make rotation about the axis quite easy.

The measuring instrument was a U micrometer with two independent heads. The frame which carried the heads was made of bronze and was carefully machined on a Brown and Sharpe universal milling machine. The top surfaces to which the micrometers were attached were made true and parallel and were so marked that when

[1] Phil Trans A vol 207, 1908, p 463, and vol 214, 1914, p 27.

the U was in position on the pier a vertical plane through these marks normal to the surfaces passed through the axis of the spool. The micrometers were mounted with their anvils, screws, and slides horizontal and the axes of the anvils in this vertical plane.

The anvil of each micrometer was a cylinder of hardened steel, about 6 mm. in diameter, and was fitted with just sufficient play to move freely in a brass block fastened to the slide. Rotation was prevented by means of a pin and slot in the usual way. The measuring end of the anvil was cut down symmetrically until the terminal surfaces, as wide as the diameter horizontally, was only about 1/2 mm. in height. This end was ground and lapped flat and normal to the axis. The other end of the anvil was rounded and during a measurement pressed against a brass arm pivoted on a horizontal axis normal to the anvil and carrying, with its axis in the (vertical) plane of motion, a half-minute spirit level. A light steel spring forced the level holder against a stop, or, during measurement, against the anvil. The force on the anvil necessary to move the level holder from the stop was less than one-quarter kilogram.

The slides and their ways were ground so flat and made so true that the zero readings of the levels were not affected by a tenth of a division (i.e. by 1/20′, corresponding to about 0.2 μ in the micrometer reading) when the slides moved over a number of millimeters. The slides were driven by the anvils of Brown and Sharpe micrometers with heads reading directly to 0.01 mm. and with estimation to 0.001 mm. easy. To facilitate the settings, light brass wheels about 6.5 cm. in diameter were attached to the barrels. The slides were held against the (non-rotating) anvils by suitable springs. Backlash was very minute, but was avoided in the usual way.

Two end standards were used, and two corresponding methods of procedure. In one method a Brown and Sharpe 300 mm. standard, with ends ground spherical to the same diameter, was mounted, approximately central and horizontal, by means of bushings, in one of the pairs of holes diametrically opposite in the spool, and the micrometers were mounted with the axes of their measuring anvils in a horizontal plane. Alternate settings could then be made upon the end standard and upon the wires at the ends of any horizontal diameter. In this way the mean diameter of either double coil could be determined.

In the other method one of the micrometers was raised 1 mm., so that the micrometers could be set upon the opposite ends of the diameters of the individual turns. The standard used for this arrangement was made from a Brown and Sharpe 325 mm. end standard with spherical ends ground to the same diameter. This was cut in two, and one piece moved laterally 1 mm. with respect to the other and at the same time the length was reduced to about 299.64 mm. The pieces were screwed and soldered together with their axes parallel. At the same time suitable bushings and adjusting rods were provided for the proper mounting of the standard with the axes horizontal and one a millimeter higher than the other in the vertical plane.

The length of the first standard and its temperature coefficient were determined at the Bureau of Standards. The length of the second, or broken, standard, was determined here with the measuring instrument described above and the first standard, the coil being an intermediary; and its temperature coefficient was assumed to equal that of the other standard, viz, 11×10^{-6} per degree C., a procedure which was entirely justified.

Most of the measurements were made by the second method, as it alone gave information about the individual spirals of each pair making up a Helmholtz coil, and only these measurements have been reduced.

Most of the measurements were made at room temperatures near 23° C. Other measurements were made at temperatures about 9° C. lower in order to determine the

temperature coefficients of the marble spool in different radial directions for each Helmholtz coil. As was to be expected after the preliminary thermal treatment given the marble, the temperature variation was found to be reversible.

The measurements at the lower temperatures were made in four azimuths differing successively by 45° on a single spiral near the center of each of the two coils numbered 1 and 4 comprising a Helmholtz pair. The mean diametrical coefficient for the marble adjacent to coils 1 and 2 was found to be $+ 8.1 \times 10^{-6}$ per degree C.; that for the marble adjacent to coils 3 and 4, $+ 6.7 \times 10^{-6}$ per degree C. Earlier researches[1] have shown that marble may have expansion coefficients differing greatly in magnitude from point to point, and in different directions, and even differing in sign. In the case here considered the measured expansion varied from 0.001 mm. to 0.008 mm. for coil 1, and from 0.010 to 0.014 mm. for coil 4.

In Figure 15 the overall diameter of each of the four spirals reduced to 23° C. is exhibited as a function of the azimuth of the lower micrometer, the azimuth of the lower ends of two of the coils being taken as zero, that of the other two as π.

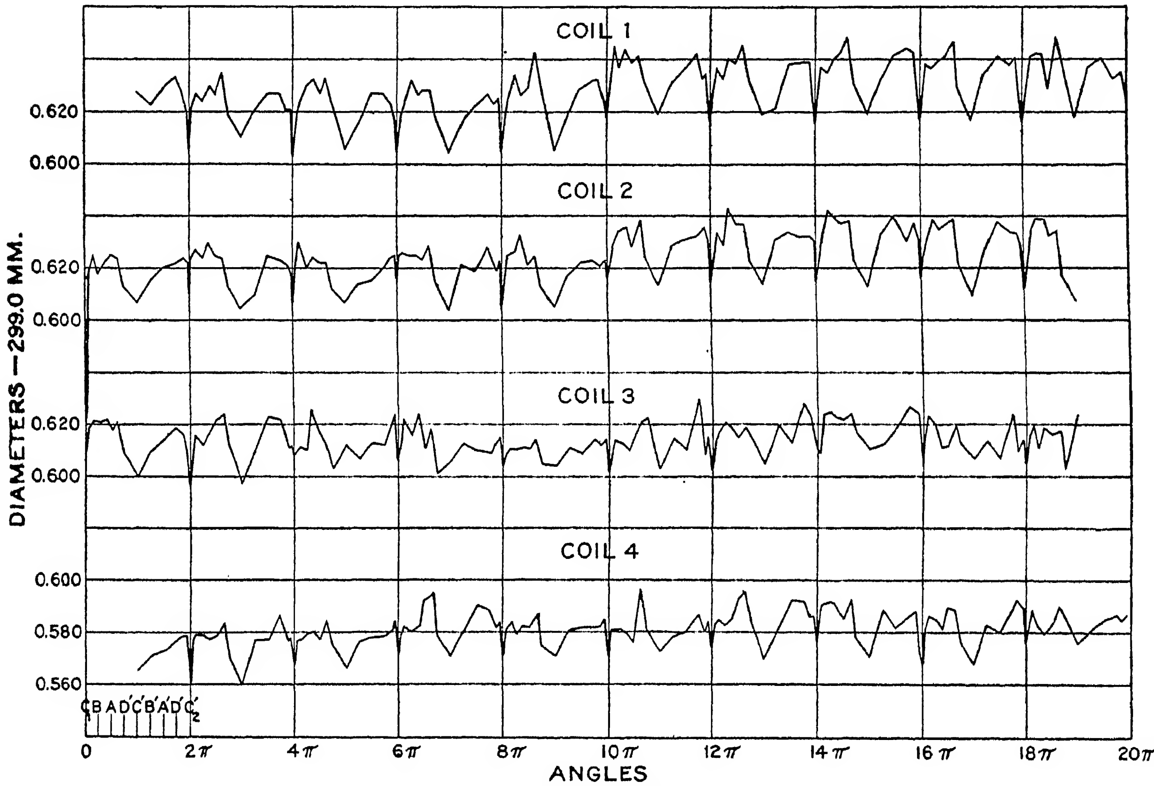

FIG. 15.—Diameters of the Spirals.

15. To determine the diameter of the wire a length of about a meter was cut off from the wire to be used. Then a coil was wound, then another length of about a meter cut off, then another coil wound, etc. The mean diameter of the wire in a coil was assumed to be the mean diameter of the two lengths at its ends. Equally spaced measurements of two diameters at right angles were taken for each length. The mean diameter of the wire for each coil was 0.576 mm., with an average departure of less than 0.001 mm., and with no difference apparent between measurements made in directions at right angles to one another.

[1] See Souder and Hindert, Scientific Papers, Bureau of Standards, No. 352, Dec. 1919.

The mean overall diameter of each spiral was obtained to 0.001 mm. from the curves of Figure 15 by means of an Amsler planimeter. By subtracting from this the diameter of the wire the mean diameter of the spiral was obtained.

The mean diameters are given in Table I.

The 30 cm. standard to which the diametral measurements were referred was correct to 1μ. From this fact and the way in which the other measurements were made, the total error in the mean diameters given in the table can hardly equal 4μ.

TABLE I. *Diameters.*

Number of spiral	Overall diameter	Mean diameter
1	299.628 mm.	299.052 mm.
2	299.624 mm.	299.048 mm.
3	299.613 mm.	299.037 mm.
4	299.581 mm.	299.005 mm.

16. The axial distances between the corresponding spirals of the Helmholtz coils were measured with a Geneva standard comparator and a special millimeter scale ruled in this laboratory and calibrated at the Bureau of Standards.

For this purpose the comparator had to be somewhat modified. The bases for holding the scales were removed and a slide with longitudinal screw motion was screwed to the movable bed with the direction of motion of the slide normal to that of the bed. On this slide was fastened a simple frame in which the spool was held with its axis horizontal and with rotation about this axis possible. The microscopes were raised on brass pillars until they were high enough to focus properly upon the top of the coil when in its frame, and were clamped in such positions that when the slide was in the center of its range the mean planes of the two Helmholtz coils were nearly in the optic axes. The scale

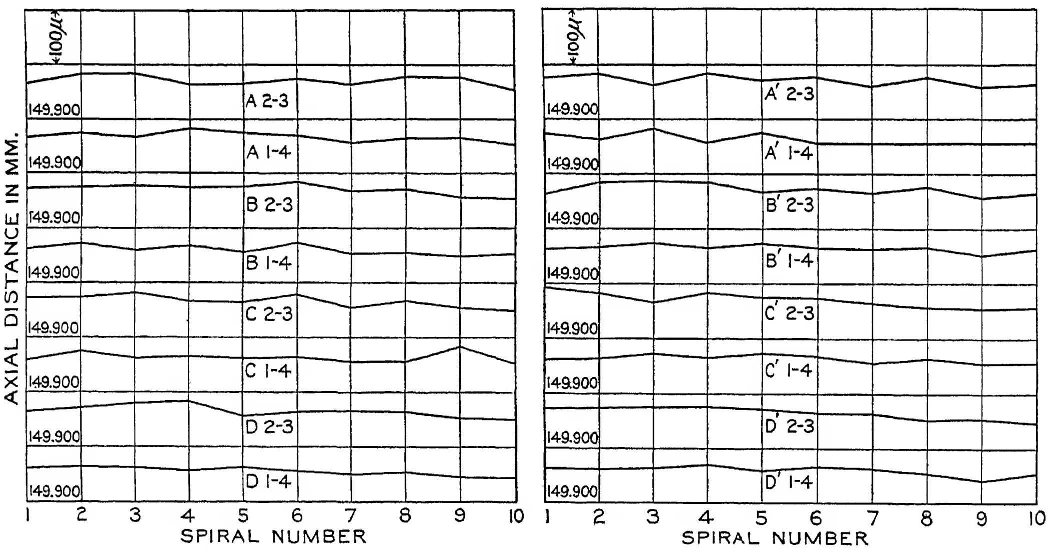

FIG. 16.—Axial Distances between Corresponding Turns of the Spirals.

was applied to the coil with its edge nearly in the vertical plane through its axis. The scale had a wedge-shaped edge which very nearly touched the wires, the plane of the divisions cutting the wires at a short distance. Such adjustments were made that when the comparator carriage was moved from one stop to the other the microscopes were focussed either on the edge of the scale or a central section of the wire. By means of the slide two corresponding wires (150 mm. apart) were brought into the microscope fields and the slide and microscopes adjusted until the images were nearly central. Micro-

scope settings were then made on both sides of each wire, and the coil was shifted until the scale came into position. The slide was then adjusted until two divisions of each scale (150 mm. apart) came to the centers of the fields (or approximately so) and micrometer settings made upon them. From the two sets of readings the axial distance between the wires was readily determined.

Systematic measurements were made in this way along eight lines parallel to the axis of the cylinder and distributed uniformly around its surface with an angle of 45° between successive lines. One set of lines, 90° apart, is designated as A, C, A', C'; the other, and intermediate, set, as B, D, B', D'. These measurements were made at temperatures not differing greatly from 23° C.; a few additional measurements at temperatures about 5° or 6° lower on two pairs of wires, along the lines A, C, A', C', made it possible to determine the axial temperature coefficient of expansion with sufficient precision.

The axial distance at 23° C. between corresponding wires for the two pairs of Helmholtz spirals, 1–4 and 2–3, is given in Figure 16 for each of the eight lines as a function of the spiral number from one end of the coil.

The mean axial distances at 23° C. for all the lines, together with the average departures, and the final means for the two Helmholtz pairs are given in Table II.

TABLE II. *Axial Distances.*

Line	Coils 2–3		Coils 1–4	
A...........	149.970	± 0.006 mm.	149.967	± 0.007 mm.
C...........	.968	8	.965	7
A′...........	.971	8	.963	8
C′...........	.971	11	.963	5
Mean..........	.970	8	.964+	7
B...........	.970	7	.961	7
D...........	.966	8	.956	6
B′...........	.973	9	.966	4
D′...........	.966	9	.961	6
Mean..........	.969–	8	.961	6
Mean..........	149.969	± 0.002 mm.	149.963	± 0.002 mm.

Measurements along line C' were made both by Dr. Ives and by myself. Our means agreed within less than 1μ, while our average difference without regard to sign was between 3μ and 4μ. The departures in the second and third columns are considerably greater than the experimental error. The close agreement in the case of each pair of coils between the means for the two sets of lines shows that it was unnecessary to increase the number of lines.

The mean coefficient of axial expansion was found to be $+10 \times 10^{-6}$ per degree C., the average departure of the individual values for the four lines A, C, A', C', from this mean being 3×10^{-6}. As remarked above, such variations are to be expected with marble. A part of the discrepancy is doubtless due to the experimental error.

In making the axial measurements each pair of wires was referred to a different pair of lines on the standard scale. The distance between each of these pairs was certified as correct within 2μ, and as probably correct within a much smaller amount. From these facts and the way in which the measurements were made, it is not probable that the error in the final means of Table II is greater than 3μ or 4μ.

17. In testing for magnetic impurities the materials used in the construction of the instrument, three methods were used.

All the materials except the marble, the glass, and the copper wire were tested by the mechanicians in the same way in which they are tested for the other instruments constructed in this laboratory. The substance is brought within a few millimeters of the north pole of one of the standard magnetometer magnets, on the west side, and the deflection observed on approach and removal. The deflection can be read to one-fifth minute. Except the telescope, too far away from the magnet and coils to have an appreciable effect, the casting supporting the magnetometer box, and some of the materials in the Edelmann base, the material was found excellent, producing either no appreciable deflection, or no deflection greater than one-fifth minute. The Edelmann base, the copper wire in the coils, the glass, the marble, and the magnetometer and its adjuncts, except the telescope and scale and the small parts holding them, were tested with an astatic magnetometer, whose magnet systems were held normal to the meridian by two small control magnets, the one very small and north of the magnet systems with its axis passing through the meridian intersecting their centers, and the other with its axis in the prime vertical passing through the systems. Both control magnets were near or below the level of the lower magnet system, and did not affect greatly the magnitude of the *N-S* component of *H* south of the system. Longitudinal motion of the first magnet altered the zero of the instrument, and longitudinal motion of the second altered the sensitivity, which was determined with a small pair of Helmholtz coils. The sensitivity being determined, the fractional change in *H* produced by bringing a substance up to within a few millimeters of the south side of the lower system could readily be found. In this way it was found that no one of the elements of construction except the base produced an alteration in *H* greater than a few parts in 10^5. Marble and paraffin are, of course, already known to be diamagnetic, with negligible susceptibility, and the copper castings were found to be so nearly pure as to be diamagnetic. The copper wire and the other pieces of metal above the base were all found to be diamagnetic or slightly magnetic except the one immediately beneath the copper box and the clamp holding the telescope arm. These pieces were about equally bad, and the worst of the metals, producing an alteration in *H* of about 1 part in 30,000. In the use of the instrument, however, they are so remote from the magnet that their effect is entirely negligible—less than 1 part in 10^5.

To test the tripod as a whole it was placed on a table which could be rapidly moved underneath the shelf on which the magnetometer was mounted, with the top of the tripod about 10 cm. below the lower magnet system, the upper system being 10 cm. or more higher. With the tripod and circles in different azimuths the scale readings were noted when the tripod was placed centrally beneath the magnetometer and when it was moved to a distance. The effect of the tripod on *H* at the lower magnet was in no case greater than about 2×10^{-5}. It was by a somewhat similar process that the last statement in the foregoing paragraph was substantiated.

Finally, the whole instrument, aside from the coil and its spool and with the exception of the copper plug and other fittings to the cylindrical chamber of the magnetometer box, the screws holding the marble spool in place, a few other screws, and the telescope and its adjuncts, was tested with an induction balance. The coil of the instrument formed one of the primaries, and two cylindrical coils in series, one on each side of the magnetometer box, the corresponding secondary. Each of the coils had a breadth of 3 cm. and internal and external diameters of 4 and 8 cm. and was clamped to the spool with the inner face only a few millimeters from the adjacent face of the copper box. When the spool was placed in position on the saddle, with the torsion tube, copper box, and castings *A* and *C* (Figure C, Plate 9) removed, or when it was removed to a distance, with all necessary precautions taken, or when, with the coil in position in the saddle, the tube, box, and castings were removed or placed in position, there was no change in the mutual inductance, tested with reversal of current and a ballistic galvanometer, greater than about 1 part in 35,000.

In this test currents twenty times as great as those normally traversing the coils of the instrument were used. As a precaution against permanent magnetization, the instrument was demagnetized by reversals from a greater current, and with the axis of the coil in two azimuths with respect to the tripod differing by 90°. None of the currents used heated the conductors appreciably.

From these tests it appears certain that any modification of the instrument's constant produced by its magnetic impurities is of no consequence.

18. In order to form an estimate of the precision with which the constant G of the coils can be determined, we may differentiate (5) logarithmically and assume that the Helmholtz relation holds exactly. We thus obtain

$$\frac{\Delta G}{G} = \frac{\Delta N}{N} - 0.4\frac{\Delta d}{d} - 0.6\frac{\Delta x}{x} \tag{8}$$

It is readily seen that $\Delta N/N$, the error in the number of turns, is quite negligible. Each coil consists, in effect, of exactly 10 turns except for the fact that the centers of the terminal holes do not lie exactly in an axial plane, that the diameter of the wire, viz, 0.576 mm., is slightly less than that of the pyralin bushings at the terminals, viz, 0.61 mm., and that the terminal loops do not lie exactly in the horizontal plane.

In order to make the first error as small as possible, the terminal holes were located and bored, with a diameter considerably larger than that of the wire, on a Brown and Sharpe universal milling machine, and the bushings were accurately machined. Nevertheless, there are slight displacements diminishing the number of turns of each coil, the mean relative displacement for the ends of coils 1 and 4 being about 0.21 mm.; that for coils 2 and 3, about 0.25 mm. If we add to these the maximum possible displacement due to the difference of diameters of wire and bushings, viz, 0.03 mm., we obtain 0.24 mm. and 0.28 mm., with a mean of 0.26 mm.—about 1 part in 36,000 of the total length of a single spiral. This would be the fractional diminution of the constant if this length of wire were simply cut off from the ten complete turns of each spiral.

A simple calculation shows that a terminal loop, if oriented into the most favorable equatorial position for producing horizontal intensity at the center of the coil system, would produce only 1/3,000 the intensity due to one of the spirals. As the loops are very nearly alike and are traversed by the current in such a way that their magnetic effects at the center of the system cancel one another in pairs, and as they lie very closely in the central horizontal plane so that their intensities at the center are very closely vertical, their effect is seen to be very minute indeed.

From these terminal loops connections are made symmetrically to the inner and outer conductors of small cylindrical coaxial cables. This is magnetically equivalent to bringing the terminals accurately together at a short distance from the points at which their peripheral displacement was 1/36,000 of the length of the spiral. The error due to this displacement is thus reduced far below this fraction; and the total error in the number of turns must be considered entirely negligible.

If we assume that the errors in the mean axial distances and the diameters are not greater than 4μ, as estimated in sections 15 and 16, equation (8) gives

$$0.4\frac{\Delta d}{d} + 0.6\frac{\Delta x}{x} = 0.4\frac{0.004}{300} + 0.6\frac{0.004}{150}$$

or about 1 part in 47,000, as the maximum possible error due to imperfect knowledge of the linear distances. This error, also, is thus entirely negligible when it is considered that the instrument was designed to measure the horizontal intensity only to 1 part in 10,000. Indeed, 1 part in 5,000 is considered sufficient by the magneticians.

No appreciable error is introduced through defective insulation. Shortly after the coils were wound the resistance between the adjacent coils of either group was not less than about 100,000 megohms. The resistance was much less some months later, when the spool had long been in a very damp atmosphere, but was still far too great to make any correction necessary. The original value can doubtless be restored and kept permanent by thorough drying and subsequent coating with paraffin.

The total error in the constant is probably less than 1 part in 30,000.

The mean diameter of coils 1 and 4, which will be treated as one Helmholtz pair, is, according to Table I, $d=299.028$ mm. at 23° C., while the mean axial distance between corresponding turns for the same pair at the same temperature is, according to Table II, $x=149.963$ mm. The number of turns N being assumed as exactly 20, equation (5) gives for the constant G_{14} of this pair, at 23° C.,

$$G_{14}=6.00316\ \frac{\text{gauss}}{\text{electromagnetic unit current}} \tag{9}$$

In the same way we obtain for the constant G_{23} of coils 2 and 3

$$G_{23}=6.00291\ \frac{\text{gauss}}{\text{electromagnetic unit current}} \tag{10}$$

and for the coils connected in series the constant

$$G=G_{14}+G_{23}=12.0061\ \frac{\text{gauss}}{\text{electromagnetic unit current}} \tag{11}$$

According to these equations, G_{14} is greater than G_{23} by about 1 part in 24,000. As an experimental check, the instrument was set up as a tangent galvanometer, with the axis of the coils in the magnetic prime vertical, and double deflections were observed (1) when a current of 0.015 ampere was sent through the coils 1 and 4 in series in the same direction, and (2) when a current of 1.50 amperes was sent through the system with coils 1–4 opposed to coils 2–3. Deflections of 245 divisions in the first case and 1.4 divisions in the second case showed that G_{14} exceeded G_{23} by 1.4 parts in 24,500.

The discrepancy between the calculated and experimental differences, only 1 part in 60,000 of the constant for a single pair, is exceedingly satisfactory.

From equation (8) and the mean temperature coefficients $\left(\frac{\Delta d}{d}\right)_{1°\text{C}}=+7.4\times10^{-6}$, as follows from §14, and $\left(\frac{\Delta x}{x}\right)_{1°\text{C}}=+10\times10^{-6}$, as given in §16, we find for the temperature coefficient of the constant G, $\left(\frac{\Delta G}{G}\right)_{1°\text{C}}=-9\times10^{-6}$.

19. Let us suppose that the instrument is correctly leveled and that the coil, with current

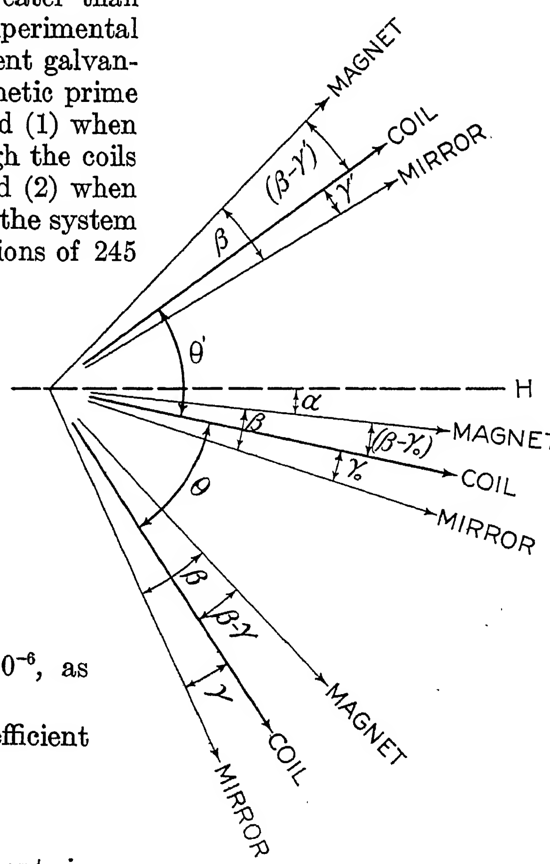

FIG. 17.—Angles Involved in the Theory of the Sine Galvanometer.

zero, is turned in azimuth until the center of the scale is on the cross-hairs of the telescope. Then the central plane of the coil, normal to its axis, will make with the magnetic meridian an angle $\alpha+\beta-\gamma_0$, as in Figure 17, which would be zero if all adjustments were perfect. The angle γ_0 is due to incorrect adjustment of telescope and scale, and would be zero if the vertical plane containing the axis of collimation and the center of the scale contained also the axis of the coil. β is the angle between the axis of the magnet and the face of the mirror, and α is an angle due to the imperfect elimination of torsion in the suspension. In the actual instrument no one of these angles need exceed a few minutes at most, as will be seen below.

Suppose now that a current I is passed through the coil in such a direction as to deflect the magnet in the clockwise direction, which will be assumed positive, and that the coil is then turned (in the same direction) through such an angle θ that the angle by which the mirror is ahead of the coil in azimuth is reduced to a small value γ. Then, if M denotes the moment of the magnet, φ the angle by which the torsion head and top of the suspension are advanced in azimuth beyond the bottom of the suspension, and K the torsional constant, we get from the lower half of the figure the relation

$$GI\cos(\beta-\gamma)=H\sin\{\theta+\alpha+(\gamma-\gamma_0)\}-\frac{K}{M}(\varphi+\gamma-\gamma_0) \tag{12}$$

If now a current I' is passed through the coil in the opposite direction, and the coil moved counterclockwise through such an angle θ' as to give to the angle by which the mirror is ahead (clockwise) of the coil in azimuth a small value γ', we get from the upper half of the figure the relation

$$GI'\cos(\beta-\gamma')=H'\sin\{\theta'-\alpha-(\gamma-\gamma_0)\}+\frac{K}{M}(\varphi+\gamma'-\gamma_0) \tag{13}$$

If the horizontal intensity is nearly the same for the two settings, we shall have H', I', and θ' but slightly different from H, I, and θ; and we get, by combining (12) and (13), remembering that α, β, γ, and γ' are small quantities, and rejecting small quantities of the second and higher orders, the relation

$$\frac{G}{2}\left(\frac{I}{H}+\frac{I'}{H'}\right)=\sin\left(\frac{\theta+\theta'}{2}\right)+\frac{1}{2}(\gamma-\gamma')\cos\left(\frac{\theta+\theta'}{2}\right)+\frac{1}{2}\frac{K}{MH}(\gamma'-\gamma) \tag{14}$$

If in a separate experiment, in the usual way, the axis of the magnet is turned from approximate parallelism with the horizontal intensity through a small angle μ by turning the torsion head through a much larger angle λ, we have, with sufficiently close approximation,

$$\frac{K}{MH}=\frac{\mu}{\lambda} \tag{15}$$

Making this substitution in (14), writing H now for the mean of the two values of the horizontal intensity, Θ for the total angle $(\theta+\theta')$ through which the coil is moved, and J for the mean of the two values of the current, we get, with a negligible error of the second order in H and I, the equation

$$\frac{GJ}{H}=\sin\frac{\Theta}{2}\left\{1+\frac{1}{2}(\gamma-\gamma')\left(\cot\frac{\Theta}{2}-\frac{\mu}{\lambda\sin\frac{\Theta}{2}}\right)\right\} \tag{16}$$

which gives, after a simple transformation, and on solution for H, the final equation

$$H=\frac{GJ}{\sin\frac{\Theta}{2}}\left\{1+\frac{1}{2}(\gamma'-\gamma)\left(\cot\frac{\Theta}{2}-\frac{\mu}{\lambda\sin\frac{\Theta}{2}}\right)\right\} \tag{17}$$

20. In the instrument described here, μ/λ, with a certain suspension of phosphor-bronze strip, is only about 0.001, and the mirror can easily be hung on the suspension in such a way that the fiber is not twisted by more than a few degrees. Thus α need not be greater than a fraction of $1'$. The angle β for the Bureau of Standards mirror is less than $2'$, and for the mirror constructed here is about $6'$. The angle γ_0, as stated above, need not exceed a few minutes at most. In using the instrument γ and γ' should also be kept small, though $\cos(\beta-\gamma)$, multiplying GI in (1), and neglected in (17), does not differ from unity by more than 0.0001 until the angle reaches nearly $50'$, corresponding to about 30 divisions on the scale when the scale distance is 35 cm. In a similar way it is seen that no appreciable error in H will be made through even a considerable error in leveling the instrument.

The angle γ_0 is made zero, or nearly zero, by the following process: First, the axis of the cylindrical chamber of the magnetometer box within which the magnet hangs is made parallel with the axis of the coils. This is done with the aid of the brass cylinder H shown in Figures A, B, and C of Plate 9 and the bent pointer shown in Figures A and B. The cylinder, which fits the chamber precisely, is pushed in until the axial motion is stopped by a terminal shoulder, and the magnetometer box is then moved in azimuth until the pointer, properly adjusted, just touches, or comes within the same minute distance of touching, the surface of the marble cylinder at both ends of a horizontal diameter. The screws clamping the two flanges C and D, Figure C, together are then tightened.[1]

Second, the axis of the cylindrical chamber is brought into the vertical plane containing the axis of collimation of the telescope and the central division of the scale (which can be shifted laterally if necessary) immediately beneath it. To accomplish this, the brass tube, Figures A and B, carrying a plane mirror at one end, is shoved into the cylindrical chamber of the magnetometer box, which it fits precisely, until the motion is stopped by a square terminal shoulder. Then the telescope, adjusted in azimuth until its axis is normal to the scale as judged by the eye, and previously focused upon the scale as seen with the magnet-mirror, is turned, together with the arm which supports it, about the axis of the magnetometer until the center of the scale is at the intersection of the cross-hairs, and clamped. As the surface of the plane mirror is only a short distance in front of the magnet-mirror, the focus is still sufficiently good. If the plane mirror is not strictly normal to the axis of the tube, the adjustment can nevertheless be made exact by using two settings of the tube 180° apart.

21. The only satisfactory method of measuring the current J through the coils of the instrument is by means of a standard resistance coil and a Weston standard cell. This can be done in three different ways.

(1) The potential difference between the voltage terminals of a standard resistance coil, with resistance R, in series with the instrument, may be made equal to the open circuit electromotive force e of a Weston standard cell by adjusting the current in the circuit. The current is then determined from the relation $J=e/R$.

(2) The potential difference E between the terminals of a standard resistance coil, with resistance R, in series with the instrument may be determined by comparison with the open circuit e. m. f. e of a Weston cell, through the agency of a standardized potentiometer or suitable arrangement of resistance coils, and J found from the relation $J=E/R$.

(3) With the arrangement of (2) otherwise unchanged, a standard cell, with open circuit e. m. f. e, may be inserted between the voltage terminals of the standard resistance coil and the potentiometer, its direction being such as to oppose the potential

[1] The cylinder H was made for use in turning the spool support. For use in making the adjustment of γ_0, a very short cylinder with as broad a shoulder as practicable, making close contact with the plane face of the magnetometer box, would be preferable, as the adjustment could then be made without removing the magnet-mirror.

difference E through the testing galvanometer, and the difference $\pm(RJ-e)=D$ determined. J can then be calculated from the relation $J=(\pm D+e)/R$.

The first method has the advantage of making it necessary to standardize only the standard resistance coil and the standard cell. It is not flexible, as all Weston cells have nearly the same e. m. f., and thus only one current can be measured with a given standard coil. A standard resistance coil can be constructed with a number of voltage terminals, however, the resistances between their points of attachment being such as to produce balances with a number of fixed currents.

The second method has the advantage of great flexibility, but requires in addition the complete standardization of the potentiometer, which contains many coils.

The third method makes it possible to measure a greater range of currents with a given standard resistance coil, and also makes it possible when D is less than E to reduce the error arising from imperfect standardization of the potentiometer. At the same time it introduces a second time whatever error there may be in the determination of e. In the practice of this method it is unnecessary to have available a second standard cell, as by a simple double-pole double-throw switch the cell by which the potentiometer current is standardized may be disconnected from its usual place and inserted in the proper place for the measurement of the unknown e. m. f., as indicated above.

22. Equation (17) gives by logarithmic differentiation

$$\frac{\Delta H}{H}=\frac{\Delta G}{G}+\frac{\Delta J}{J}-\cot\frac{\Theta}{2}\,\Delta\frac{\Theta}{2}+\left(\cot\frac{\Theta}{2}-\frac{\mu}{\lambda\sin\frac{\Theta}{2}}\right)\Delta\frac{(\gamma'-\gamma)}{2} \tag{18}$$

for the error in H due to all the other errors involved.

In Table III the cotangent and the reciprocal of the sine of $\frac{\Theta}{2}$ are given as functions of $\frac{\Theta}{2}$. Since $\Delta\frac{\Theta}{2}$, the error in $\frac{\Theta}{2}$, need not exceed 1″ or 2,″ or 5 or 10×10^{-5} radian, and the error in the scale readings, $\Delta\left(\frac{\gamma'-\gamma}{2}\right)$, need not exceed 10″ (at the scale distance 34.4 cm. when 1 small division = 100″), or 5×10^{-5} radian, it is clear that at large angles, which should be used when great precision is required, the errors comprised in the last two terms of (18) can be neglected entirely, if H is desired only to 1 part in 10^4.

The error $\Delta J/J$ in determining the current in absolute electromagnetic units with the aid of a standard resistance and a Weston cell need not, according to the experience of the National Physical Laboratory and the National Bureau of Standards, exceed about 2 or 3×10^{-5}.[1]

The error $\Delta G/G$ in determining the coil constant we have already seen to be probably less than 1 part in 30,000.

With the instrument as constructed it should therefore be possible to measure the horizontal intensity with an error less than 1 part in 10,000.

23. Early in June, after preliminary tests in the Experiment Building, the sine galvanometer, together with a Weston cell, a 10-ohm standard resistance coil by Wolff, a standard potentiometer, also by

TABLE III.

$\frac{\Theta}{2}$	$\cot\frac{\Theta}{2}$	$\frac{1}{\sin\frac{\Theta}{2}}$
°		
20	2.75	2.92
30	1.73	2.00
40	1.19	1.56
50	0.84	1.30
60	0.58	1.16
70	0.36	1.06
80	0.18	1.02
85	0.09	1.004
87	0.052	1.0014
88	0.035	1.0006
89	0.017	1.0002
90	0.000	1.0000

[1] See Rosa, Dorsey, and Miller, Bulletin of the Bureau of Standards, vol. 8, 1912, pp. 269, 362.

Wolff, and the necessary accessory apparatus, with the exception of a large capacity storage battery, located in the main building, was set up in the Standardizing Observatory by Mr. Fleming and myself. With the help of Mr. Fisk and Mr. Peters a long series of simultaneous determinations of the horizontal intensity was then made with the galvanometer and C. I. W. standard magnetometer No. 3. The later and better part of these observations, together with a more complete series made in August by Messrs. Fleming, Fisk, and Ives, is briefly treated by Mr. Fleming in a summary published in this volume (Absolute Standard in Horizontal Intensity, p. 468).

Throughout the work with the sine galvanometer the electrical measurements were made by the method (2) of §21. The galvanometer was used according to the method described in §19, H being calculated in absolute measure from equation (17). For each setting of the coil a number of scale readings were taken at regular intervals in order to follow the variations of H more closely and to secure better mean values.

The half-period of the magnet for the values of θ and θ' used, viz, from 65° to 74°, corresponding to currents from 0.14 to 0.15 ampere, is about a second, and the motion is heavily damped. At the same time the circle and scale are clear and well illuminated and can be read with the greatest ease. Hence, with constant current, which is not difficult to secure, a complete determination can be made very quickly.[1] With practice several such determinations can be made in one minute, provided scale-readings are not multiplied. In the observations referred to a determination with multiplied scale-readings ordinarily required two minutes or less. The advantages over the magnetometer in saving time and in obtaining more nearly instantaneous measurements are quite apparent, as a complete determination with a magnetometer requires at least from half an hour to an hour.

As shown by Mr. Fleming's table, the results obtained with the two instruments agree with extreme closeness, the mean discrepancy being only 0.7γ, or about 1 part in 25,000. Any agreement beyond 1 part in 10,000, or thereabout, would, however, have to be considered accidental even if the electrical standardizations were given with the greatest precision practicable; and such standardizations have not yet been obtained. According to the Bureau of Standards, the certified e. m. f. of the Weston cell used is correct to 1 part in 10,000; the certified resistance of the standard coil is correct within 1 part in 20,000; and the potentiometer can be relied on to within 1 part in 10,000. Hence it is known only that the currents are not in error by as much as 1 part in 4,000. It is unlikely, however, that the three contributing errors are all effective in the same direction; and the standardizations are probably, as is usually the case with the Bureau of Standards, more precise than the claims of the certificates. Hence it is probable that the actual error in the currents is considerably less than 1 part in 4,000; but it will be impossible to say how much less until more precise values of the standards have been obtained.

24. This work was undertaken at the request of Dr. Bauer, who has taken great interest in its progress and who has seen that adequate facilities for it were provided. My colleague, Mr. Fleming, has also taken great interest in the work and has made some useful suggestions. The non-magnetic castings were made by Mr. C. Huff, who did most of the work on the tripod and the magnetometer supports. The chief instrumental work, including the most difficult parts, viz, the turning of the marble spool and the construction of the measuring devices, was done with great skill and patience by Mr. G. H. Jung, whose ingenuity relieved me of many details. Dr. G. H. Wait and Dr. J. E. Ives have done the greater part of the work involved in making and reducing the linear measurements. I am indebted also to Mrs. Barnett for assistance in many parts of the work, and to Mr. C. A. Kotterman for the illustrations.

[1] When a long series of observations is in progress, the work can be facilitated by using stops to keep $\theta + \theta'$ constant, the variations in H for constant current being found from the scale-readings.

RESULTS OF COMPARISONS OF MAGNETIC STANDARDS, 1915-1921.

By J. A. Fleming.

EXPLANATORY REMARKS.

This report contains, in continuation of the report for 1905 to 1914 in Volume II (pp. 211–278), the results of the various intercomparisons of magnetic standards obtained by the observers of the Department of Terrestrial Magnetism from 1915 to 1921, inclusive, the world over, at magnetic observatories and in the field. Preliminary summaries of the results of some intercomparisons in recent years by others and exhibit of the relation of these results to those of the Department are also given. As heretofore, it has been found that, for one reason or another, magnetic instruments may differ among themselves by quantities far exceeding their observational errors. Sometimes these differences can be referred to imperfect values of the instrumental constants, at other times they are to be ascribed to causes inherent in the instruments themselves.

When, therefore, a general magnetic survey of the globe is to be conducted on a common and consistent plan, it becomes a matter of importance to know how far instrumental constants and reductions to standards, as determined at one place, can be relied upon in other places where the magnetic elements are considerably different, or what changes may be expected during strenuous field campaigns, such as must be carried out in more or less unexplored countries. If, furthermore, the magnetic results obtained by various organizations, using instruments of greatly different construction, are all to be reduced to a common basis, it becomes increasingly important to have the requisite data at hand for the proper correlation of all work.

Accordingly, whenever opportunity was presented during 1915 to 1921 in the course of field work to obtain such correlation data, the observers of the Department have carried out, with the cooperation of the staffs of the various observatories visited, series of intercomparisons of magnetic instruments. Whenever circumstances permitted, the *method of intercomparisons* of magnetic instruments described in Volumes I (pp. 19–20) and II (pp. 211–212), was followed. Only occasionally did it happen that, for lack of time or other reason, the full program had to be curtailed. The method as prescribed in the general directions for magnetic measurements given observers of the Department is shown in the following paragraphs:

"Disturbed sites are avoided for the intercomparisons of instruments, but this can not always be done in the field, as for example, in the ocean work where islands, or ports, often afford the only opportunity for the desired comparisons. If the preliminary examination has shown the existence of pronounced local magnetic disturbance, and if another site is not available, it is arranged that, at the same station, the magnetic systems of the various instruments are in the same horizontal plane. Should this procedure not be possible, then the height of magnet from a suitable reference point, e. g., from the top of a stake driven into the ground, is carefully noted and determinations are made at each station to find the necessary corrections for the various levels in which the intercomparisons had to be secured. With these precautions, it has been found that results of sufficient accuracy for field work can be obtained.

"Generally but two stations are required, which, unless already named, as may be the case at observatories, are designated *A*, *B*. For observatory work *B* is the auxiliary station and *A* the regular observing-pier; at some observatories different piers or stations are used for the various elements and intercomparisons for each particular element must be made accordingly. The azimuth lines for both stations are preferably referred to the same determination of azimuth, especially when no exchange of stations can be effected. Whenever possible both stations are placed in the same azimuth line and the same mark is used at each, thus assisting in the avoidance of extraneous

error. Triangulation between stations for azimuths of marks is resorted to only when absolutely necessary.

"*To secure reliable results expeditiously, simultaneous observations with the instruments being compared are preferred, as also an exchange of stations; in this way any possible station-difference may be at once eliminated and the desired instrumental-difference be derived without recourse to auxiliary instruments, e.g., magnetographs.* At observatories where the same piers used in determining the magnetograph base-lines may be utilized and the required magnetogram-data be obtained promptly, there may be no necessity for an exchange of stations and simultaneity of observations, though this is found, in general, to be the better procedure. When tripods must be used, each instrument is mounted each time on its own tripod.

"When, for some reason, simultaneous observations are not possible, the observations are carried out alternately at each station by the same observer with the two instruments 1 and 2, and the stations A and B as follows: observations with 1 at A, with 2 at B; 2 at B, 1 at A; 1 at A, 2 at B; 2 at B, 1 at A; and so on; next, 2 at A, 1 at B; 1 at B, 2 at A; 2 at A, 1 at B; 1 at B, 2 at A; and so on. As little time as possible is allowed between determinations at the two stations in order to minimize outstanding effects of corrections to common epoch. With the number of determinations called for, this scheme of observation, while of course not as good as simultaneous intercomparisons, nevertheless yields good results when used with care.

"Whenever possible, the practice is to secure with each instrument at least 12 complete determinations of declination, 6 at each station; 6 complete determinations of horizontal intensity, 3 at each station (one determination consisting of two sets of oscillations and two sets of deflections at two or more distances); and at least 6 determinations of dip with each needle, 3 at each station. The observations are made for different orientations of the footscrews of the instruments, preferably so that there will be an equal number of observations at each station for footscrew marked A south, footscrew B south, and footscrew C south. The work for any one element is not completed on one day, but distributed over several days in order to minimize a possible effect due to magnetic perturbations. Where an exchange of stations is not practicable, the total number of determinations for each element is at least as great as just stated. Particular care is used to see that the instruments are in good working order and the requisite caution is exercised to insure the absence of disturbing influences of whatever character. Before leaving the station, the computations are completed far enough to make sure, at least, that no observational blunders have been made."

The *instruments* used by the Department observers are designated by their respective numbers, which will serve at the same time, by referring to Volume I (pp. 2–11), to Volume II (pp. 5–15), and to the present volume (pp. 6–8) to identify and to describe them. The magnetometers are almost invariably of the design[a] of the Department, in most cases constructed directly in its own instrument shop, or according to its own specifications. The dip circles, with the exception of Casella Nos. 18 and 4655, and Barrow Nos. 38 and 41, are of Dover make, with certain modifications in some cases as specified by the Department, or of the universal-magnetometer type[a] as designed and constructed by the Department. Earth inductors Nos. 2, 5, 6A, and 48 are of the Wild-Eschenhagen type, the first two constructed by Toepfer, of Potsdam, and the last two by Schulze, also of Potsdam; earth inductors Nos. 3, 4, 7, and magnetometer-inductors Nos. 24 to 28 are of types[b] designed and constructed by the Department.

The *corrections* applied to the magnetometers and dip instruments in order to refer the results obtained to the provisionally adopted standards of the Department are as enumerated in the present volume (pp. 9–18).

The *provisional standards* of the Department of Terrestrial Magnetism for the comparison results obtained up to the end of 1914 were the same as for the results of the field work during the period 1905–1913, namely: For declination, C.I.W. magnetometer No. 3 without correction; for horizontal intensity, C.I.W. magnetometer No. 3 with a correction of $+0.00015H$ applied to observed values of H, the horizontal intensity; for

[a] See "Two new Types of Magnetometers Made by the Department of Terrestrial Magnetism of the Carnegie Institution of Washington," by J. A. Fleming, *Terr. Mag.*, Vol. 16, 1911, pp. 1–12; also *Res. Dep. Terr. Mag.*, Vol. I, pp. 2–7, and Vol. II, pp. 5–12.

[b] See "Description of the C. I. W. Marine Earth-Inductor," by J. A. Fleming, *Terr. Mag.*, Vol. 18, 1913, pp. 39–45; also "Description of the C. I. W. Combined Magnetometer and Earth Inductor," by J. A. Fleming and J. A. Widmer, *Terr. Mag.*, Vol. 18, 1913, pp. 105–110; also *Res. Dep. Terr. Mag.*, Vol. II, pp. 9–12.

inclination, earth inductor No. 48 with a correction of −0′.5 applied to observed values of inclination. As a result of the preliminary investigations in Volume II (pp. 271–273) of the results obtained during 1905 to 1914 we arrived at what were provisionally termed "International Magnetic Standards" (I.M.S.), which were shown to have remained constant within all practical requirements. These standards have been used for all the data given in the present report. The results of the comparison observations following (pp. 397–474), have confirmed the belief that the "I.M.S." would be found to answer all practical purposes. No special explanation is required except that "I.M.S." means the result obtained by the observer of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington as reduced to the standards just specified. Additional details regarding the comparisons will be found in the final summaries (pp. 474, 475).

Throughout the tables, declination, *D*, east, and inclination, *I*, north end of needle below horizon, are designated by the plus sign. The difference, I.M.S.—Observatory, is taken algebraically. Horizontal intensity, *H*, is regarded as plus, whether the value applies to the northern or to the southern magnetic hemisphere. For convenience in expressing the *H*-differences, the values of *H* are given in gammas (γ), i. e., in units of the fifth decimal C.G.S. The mean *H*-difference is, furthermore, expressed in parts of the observed *H* for the purpose of facilitating its application to places of different *H*. It is not correct, as may have been first pointed out by L. A. Bauer,[a] to assume that the intensity correction of a magnetometer, expressed in absolute units, will remain the same with change of magnetic field, the amount of the correction depending, in fact, upon the absolute value of the intensity at the place of observation. From whatever source the correction generally arises, it can be expressed, with close approximation, by a simple ratio change, i. e., a factor multiplied into the first power of the value of the intensity; only in certain extreme cases will a second term, involving the second power of the intensity, enter appreciably.

It is a pleasure to record our indebtedness to the directors of the various observatories, and to the members of their staffs, for the very cordial assistance rendered, as well as our appreciation of the uniform courtesies extended to the representatives of the Department.

NO. 1.—AGINCOURT OBSERVATORY, NEAR TORONTO, CANADA.

COMPARISONS AT WASHINGTON, 1915.

Comparisons of field magnetometer No. 15, of the Meteorological Service of Canada, and of earth inductor Toepfer No. 89, the standard of the Agincourt Observatory, were secured in November and December 1915 at the Standardizing Magnetic Observatory of the Department of Terrestrial Magnetism at Washington, D. C., by Observers W. E. W. Jackson of the Meteorological Service and H. W. Fisk of the Department. C.I.W. standard magnetometer No. 3 and C.I.W. standard earth-inductor Schulze No. 48 were used in the comparisons. The Meteorological-Service magnetometer No. 15 is a theodolite-magnetometer made in the workshop of the Department of Terrestrial Magnetism, and is similar to type 1(*b*) described in Volume I, *Researches, Department of Terrestrial Magnetism*, pages 3 to 5. The observations were made at the two tripod-stations N_m and S_m, and at the three piers N_e, S_e, and E_m, of the Standardizing Magnetic Observatory; a full description of this Observatory and a plan showing the locations of the stations is given in Volume II, pages 199 to 200 and Fig. 9. The galvanometers used for the observations with the earth inductors were mounted on piers N_g, S_g, and E_m.

[a] *Terr. Mag.*, Vol. 12, p. 161, foot-note.

When the constants for magnetometer No. 15 were determined in April 1910 by the Department of Terrestrial Magnetism, at Washington, D. C., the following quantities were obtained:

C. I. W.—Meteorological-Service magnetometer No. 15 = +0′.1.
C. I. W.—Meteorological-Service magnetometer No. 15 = +0.00035H, using constants of April 14, 1910.

Whence (see Vol. II, p. 273)

I. M. S.—Meteorological-Service magnetometer No. 15 = 0′.0 (1910).
I. M. S.—Meteorological-Service magnetometer No. 15 = +0.00020H (1910).

The comparisons in April 1910 included an exchange of stations to eliminate station-difference. During 1910 to 1915 magnetometer No. 15 was used for field work involving unusually severe conditions of travel. In April 1910 the mean difference between readings for magnet 15L erect and inverted was −4′.1, while in December 1915 it was only −0′.1. The change in the value of the declination-difference on I. M. S. between 1910 and 1915 is possibly because of slight imperfections, or displacements, of the optical parts of the collimating system; a careful examination in 1915 did not reveal any other probable explanation. For horizontal intensity, the values for the difference on I. M. S. obtained in 1910 and 1915 (Table 1B) are in good agreement.

For inclination, the difference on I. M. S. of earth inductor Toepfer No. 89, obtained at Washington in 1915 (Table 1C), supersedes that derived indirectly for 1910 to 1912, as given on pages 216 and 278 of Volume II. The disagreement in the two values is doubtless to be ascribed to the uncertainties in obtaining the earlier value, viz, lack of data for determining a possible station-difference between the large inductor-pier C and the piers D and E of the Agincourt Observatory, and possible changes in the various dip circles involved in the comparisons.

TABLE 1A.—*Results of Declination Comparisons at the Standardizing Magnetic Observatory of the Department of Terrestrial Magnetism at Washington, 1915.*

Date	Local mean time		Declination obtained[1]		I. M. S.—M. S. 15	Remarks
	From	To	I. M. S.[2]	M. S. 15		
1915	h m	h m	° ′	° ′	′	
Nov. 29	15 40	15 49	−4 38.0	−4 36.8	−1.2	C. I. W. No. 3 at S_m; M. S. No. 15 at E_m.
29	15 52	16 01	37.7	36.7	−1.0	
30	11 45	11 54	37.1	36.5	−0.6	
30	11 56	12 05	37.2	36.7	−0.5	
30	13 44	13 53	36.9	36.8	−0.1	
30	13 56	14 05	37.0	36.8	−0.2	
30	15 54	16 03	37.4	35.9	−1.5	
30	16 05	16 14	37.3	36.2	−1.1	
Dec. 1	9 09	9 18	34.5	33.7	−0.8	
1	9 21	9 30	34.5	33.3	−1.2	
1	11 46	11 55	38.9	37.6	−1.3	
1	11 57	12 06	39.3	38.3	−1.0	
1	14 04	14 13	38.6[3]	37.6	−1.0	
2	9 36	9 45	34.9	34.1	−0.8	C. I. W. No. 3 at E_m; M. S. No. 15 at S_m.
2	10 17	10 26	35.5	33.8	−1.7	
2	12 52	13 01	37.5	36.7	−0.8	
2	14 17	14 26	37.4	36.5	−0.9	
3	9 23	9 32	33.6	33.3	−0.3	
3	9 56	10 03	34.9[4]	33.8[4]	−1.1	
3	12 30	12 38	39.9	39.4	−0.5	
Mean value of (I. M. S.—M. S. 15)..........					−0.9	

[1] All values are referred to station S_m; $S_m = E_m + 0'.1$, as derived from this series. Observers: M. S. No. 15, W. E. W. Jackson of the Meteorological Service; C. I. W. No. 3, H. W. Fisk of the Department of Terrestrial Magnetism.
[2] These are values obtained with C. I. W. No. 3 referred to I. M. S.; I. M. S.—C. I. W. No. 3 = −0′.1.
[3] This value was corrected for error in setting of torsion-head.
[4] This value was obtained from 4 magnet-inverted and 2 magnet-erect readings only.

TABLE 1B.—*Results of Horizontal-Intensity Comparisons at the Standardizing Magnetic Observatory of the Department of Terrestrial Magnetism at Washington, 1915.*

Date	Local mean time		Hor. int. obtained[1]		I. M. S.—M. S. 15	Remarks
	From	To	I. M. S.[2]	M. S. 15[3]		
1915	h m	h m	γ	γ	γ	
Nov. 30	9 38	11 32	18976	18979	−3	C. I. W. No. 3 at S_m; M. S. No. 15 E_m.
30	14 15	15 46	985	984	+1	
Dec. 1	9 55	11 35	974	968	+6	
1	14 19	16 37	981	985	−4	C. I. W. No. 3 at E_m; M. S. No. 15 at S_m.
2	10 36	12 42	978	976	+2	
2	14 32	16 42	994	990	+4	
3	10 14	12 16	960	956	+4	
Mean value of (I. M. S.—M. S. 15)...............					+1.4γ or +0.00007H	

[1] All values are referred to station S_m; $S_m = E_m - 4.8\gamma$, as derived from this series. Observers: M. S. No. 15, W. E. W. Jackson of the Meteorological Service; C. I. W. No. 3, H. W. Fisk of the Department of Terrestrial Magnetism.

[2] These are the values obtained with C. I. W. No. 3, using constants of December 12, 1910, referred to I.M.S.; I. M. S.—C. I. W. No. 3 = 0.00000H.

[3] Constants of April 14, 1910, were used in obtaining these values.

TABLE 1C.—*Results of Inclination Comparisons at the Standardizing Magnetic Observatory of the Department of Terrestrial Magnetism at Washington, 1915.*

Date	Local mean time		Inclination obtained[1]		I. M. S.—M. S. 89	Remarks
	From	To	I. M. S.[2]	M. S. 89		
1915	h m	h m	° ′	° ′	′	
Dec. 3	15 05	15 36	+71 01.6	+71 02.0	−0.4	C. I. W. No. 48 at S_e; M. S. No. 89 at E_m.
3	15 50	16 14	01.6	01.7	−0.1	
4	9 27	9 54	03.0	03.1	−0.1	
4	10 10	10 36	03.5	03.5	0.0	
4	11 08	11 28	03.3	03.4	−0.1	
4	11 40	12 08	03.0	03.1	−0.1	
4	14 06	14 34	02.1	02.1	0.0	C. I. W. No. 48 at E_m; M. S. No. 89 at S_e.
4	14 47	15 16	01.8	01.9	−0.1	
4	15 44	16 20	01.4	01.8	−0.4	
6	9 26	10 03	03.6[3]	03.6[3]	0.0	
6	10 41	11 07	04.8[3]	05.0[3]	−0.2	
6	13 44	14 16	06.8[3]	07.1[3]	−0.3	
Mean value of (I. M. S.—M. S. 89).......					−0.15	

[1] All values are referred to station S_e; $S_e = E_m + 0'.0$, as derived from this series. Observers: M. S. No. 89, W. E. W. Jackson of the Meteorological Service; C. I. W. No. 48, H. W. Fisk of the Department of Terrestrial Magnetism.

[2] These are values obtained with C. I. W. No. 48; I. M. S.—C. I. W. No. 48 = 0′.0.

[3] A magnetic storm was in progress during these observations; extreme precautions were taken to make the observations with the 2 instruments strictly simultaneous.

COMPARISONS AT AGINCOURT, 1916.

Declination and horizontal-intensity comparisons with Agincourt standards were secured by the Observatory staff in April 1916 through observations with the Meteorological-Service magnetometer C.I.W. No. 15 after its return from Washington. Director R. F. Stupart has courteously communicated the results of the comparisons as shown by Tables 1 D and 1 E and accompanying foot-notes, thus making it possible to obtain once again relations between the Agincourt standards and I.M.S. The Director of the Meteorological Service stated, when communicating these data, that beginning with January 1916 all Agincourt values in declination would be referred to pier E and corrected on I.M.S. by the means of the relations deduced from the comparisons at Agincourt during April 1916 in declination and horizontal intensity; he stated also that inclinations obtained through the Toepfer inductor No. 89 would be corrected on I.M.S. by the relation as determined by the Washington comparisons of

December 1915.[a] Beginning with 1916 the relations adopted by the Director of the Meteorological Service are:[b]

(*a*) I.M.S. at Agincourt pier E = Agincourt (Toronto declinometer at pier A) $-0'.9$.
(*b*) I.M.S. at Agincourt pier E = Agincourt (Elliott magnetometer No. 98 at pier E) $+0.00039H$.[c]
(*c*) I.M.S. at Agincourt pier E = Agincourt (Toepfer inductor No. 89 at pier C) $-0'.15$.

TABLE 1D.—*Results of Declination Comparisons at the Agincourt Observatory, 1916.*

Date	Mean time 75th meridian	Declination obtained: Agincourt[1] (pier A)	Declination obtained: M. S. 15[2] (pier E)	Agincourt (pier A)—M. S. 15 (pier E)	Remarks
1916	h m	° ′	° ′	′	
April 4	10 48	−6 29.9	−6 29.9	0.0	M. S. magnetometer No. 15 at A.[3]
4	11 42	33.7	34.0	+0.3	
4	11 54	34.6	35.3	+0.7	
4	13 10	39.0	38.7	−0.3	
4	13 22	39.4	39.2	−0.2	
4	13 34	39.8	39.6	−0.2	
4	13 46	40.1	39.8	−0.3	
4	14 16	40.3	40.4	+0.1	
4	14 28	40.1	40.1	0.0	
4	14 40	39.8	39.8	0.0	
5	9 31	21.7	21.5	−0.2	M. S. magnetometer No. 15 at E.[4]
5	9 40	22.1	22.4	+0.3	
5	10 19	24.6	24.4	−0.2	
5	10 28	25.2	25.1	−0.1	
5	10 40	26.2	26.1	−0.1	
5	10 50	27.0	27.3	+0.3	
5	11 18	29.3	29.3	0.0	
5	11 26	30.2	30.5	+0.3	
5	11 33	30.9	31.0	+0.1	
5	11 43	32.0	32.0	0.0	
5	11 51	32.8	32.8	0.0	
5	14 10	41.0	40.9	−0.1	M. S. magnetometer No. 15 at F;[5] Agincourt declinometer at A.
5	14 39	40.9	41.1	+0.2	
5	14 50	40.8	40.8	0.0	
5	15 10	40.8	40.8	0.0	
5	15 20	40.5	40.5	0.0	
5	15 29	40.3	40.4	+0.1	
6	9 31	21.9	22.0	+0.1	
6	9 40	25.5	25.4	−0.1	
10	9 26	26.1	26.3	+0.2	
10	9 48	27.0	27.0	0.0	
Mean value of [Agincourt (pier A)—M. S. 15 (pier E)]				+0.03	

[1] Values for Agincourt standard at pier A obtained from eye readings of magnetograph using base-line as determined by the 10 sets of observations with Toronto declinometer at pier A made simultaneously with magnetometer No. 15 at pier F.

[2] All values by magnetometer No. 15 referred to pier E since former comparisons between it and Agincourt declinometer were always made with magnetometer No. 15 on this pier, and no allowance was made for station-difference between piers A and E; $E = A + 0'.38 = F - 0'.24$.

[3] For this series magnetometer No. 15 was mounted on pier A as close as possible to the Observatory declinometer, and simultaneous readings were taken on the magnetograph. Observers were: magnetometer No. 15, W. E. W. Jackson; magnetograph, W. Menzies.

[4] Observers were: magnetometer No. 15, W. E. W. Jackson; magnetograph, W. Menzies.

[5] Observers were: magnetometer No. 15, W. E. W. Jackson; declinometer, W. Menzies; magnetograph, A. R. O. Wakely.

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[a] Thus the published values for declination and horizontal intensity would apply for pier E, while the inclination would apply for pier C upon which the inductor is mounted; presumably the station-difference in inclination between piers C and E is negligible.

[b] See "Results of Observations at the Canadian Magnetical Observatories Agincourt and Meanook for the Year 1916," by W. E. W. Jackson, Ottawa, 1919, pp. 3–8.

[c] This correction does not quite agree with that determined in formula (*i*) below because of error in mean value for (Agincourt—M. S. 15), which is given as -5.1γ (or $-0.00032H$) on page 6 of the reference cited in foot-note 2 above instead of -5.6γ (or $-0.00035H$).

TABLE 1E.—*Results of Horizontal-Intensity Comparisons at the Agincourt Observatory, 1916.*

Date	Mean time 75th meridian	Hor. int. obtained[1]		Agincourt —M. S. 15	Remarks
		Agincourt[2]	M. S. 15[3]		
1916	h m	γ	γ	γ	
April 6	11 20	15963	15968	− 5	Agincourt magnetometer No. 98 at *E*; M. S. magnetometer No. 15 at *F*.
6	14 35	5979	5984	− 5	
7	11 04	5972	5974	− 2	
7	14 32	5989	6000	−11	
10	13 58	5990	5992	− 2	Agincourt magnetometer No. 98 at *F*; M. S. magnetometer No. 15 at *E*.
11	10 39	5967	5976	− 9	
11	14 24	5995	6003	− 8	
12	12 30	5991	5994	− 3	
Mean value of (Agincourt — M. S. 15)....				− 5.6 γ or −0.00035*H*	

[1] All values are referred to pier *E*, which is used by the Observatory for the horizontal-intensity observations; $E = F - 12.4\gamma$ as derived from this series. Observers were: magnetometer No. 98, W. Menzies; magnetometer No. 15, W. E. W. Jackson.

[2] These values were obtained using constants for magnetometer No. 98 as determined in February 1911 at Agincourt.

[3] These values were obtained using constants for magnetometer No. 15 as determined during February and March 1910 at Washington.

From Tables 1D and 1A we have, since $E = A + 0'.38$:

(*d*) Agincourt (Toronto declinometer)−M. S. magnetometer No. 15 = +0′.4.
(*e*) I. M. S.−M. S. magnetometer No. 15 = −0′.9.

Hence we get:

(*f*) I. M. S.−Agincourt (Toronto declinometer) = −1′.3.

From Tables 1E and 1B we have:

(*g*) Agincourt (Elliott magnetometer No. 98)−M.S. magnetometer No. 15 = −0.00029*H*.
(*h*) I. M. S.−M.S. magnetometer No. 15 = +0.00007*H*.

Hence we get:

(*i*) I. M. S.−Agincourt (Elliott magnetometer No. 98) = +0.00042*H* (weight 1).[a]

INDIRECT COMPARISONS, 1915–1921.

In May and June 1921, at the request of Dr. Otto Klotz, director of the Dominion Observatory, C.I.W. universal-magnetometer No. 20, belonging to the Dominion Observatory, was compared at the Standardizing Magnetic Observatory of the Department at Washington. It was found that, by reason of change in the moment of inertia of the long magnet and its stirrup in the course of field work since the previous determination at Washington in March 1916, the correction on I.M.S. in intensity had changed 0.00055*H*, i.e., from −0.00023*H* to −0.00078*H*. The actual difference in observed moments of inertia determined at the same time as the two comparisons was equivalent to 0.00076*H*, in good agreement with the observed change of differences on I.M.S. The correction on I.M.S. in declination, −0′.7, observed in 1921, was identical with the earlier one.

This magnetometer was also compared before and after each summer's field campaign with I.M.S. as defined at Agincourt by the relations above given (see p. 400). Dr. Klotz has communicated the results of these comparisons, made by Observer C. A. French of the Observatory staff; they are summarized in Table 1F. The individual results, except for the October 1918 comparisons, and the mean results show excellent agreement and, accordingly, constancy of adopted I.M.S. in declination and horizontal intensity, well within the errors of observation, both at Agincourt and at Washington.

Dominion Observatory universal-magnetometer C. I. W. No. 20 being of the dip-circle type can not be considered of precision equal to the standard earth-inductors

[a] See foot-note 3 on p. 400.

No. 1911 by Toepfer and No. 89 by Toepfer of the Dominion Observatory and Agincourt respectively, particularly so as the examination in 1921 of No. 20 showed that its lifting wyes had changed in adjustment, doubtless owing to long field service. It is, however, interesting to note that the weighted mean value of (I. M. S. at Ottawa — D. O. No. 20) from 27 sets of 4 needles each in 1916 and 1917 and of (I.M.S. at Agincourt — D.O. No. 20) from 12 sets of 4 needles each in 1919 and 1920 as determined by Mr. French, using (I. M. S.—D. O. No. 1911) = $-0'.25$ (see p. 419) and (I. M. S.—Agincourt No. 89) = $-0'.15$ (see p. 400), is $-0'.1$. The mean value of (I. M. S. at Washington—D. O. No. 20) determined in 1915, $+0'.1$, and again in 1921, $-0'.3$, is $-0'.1$.

From the indirect comparisons of 1915 to 1921 as in Table 1F, we have:

(*j*) I. M. S. — Agincourt (Toronto declinometer) = $-1'.3$.
(*k*) I. M. S. — Agincourt (Elliott magnetometer No. 98) = $+0.00038H$ (weight 3).

TABLE 1F.—*Results of Indirect Comparisons at Agincourt Observatory through Dominion Observatory Magnetometer No. 20, 1915–1921.*

Date	(I. M. S. at Agincourt — D. O. 20)				(I. M. S. at Washington — D. O. 20)				I. M. S. at Washington — I. M. S. at Agincourt	
	No. sets	Declination	No. sets	Hor. int.	No. sets	Declination	No. sets	Hor. int.[1]	Declination	Hor. int.
		′				′			′	
Mar., 1915	......	......	......	....	12	−0.72	6	$-0.00023H$	......	....
May, 1916	20	−0.9	6	$-0.00052H$	......	−0.7	......	$-0.00034H$	+0.2	$+0.00018H$
Oct., 1916	14	−0.9	3	$-0.00044H$	......	−0.7	......	$-0.00038H$	+0.2	$+0.00006H$
Oct., 1918	10	−0.9	4	$-0.00011H$	......	−0.7	......	$-0.00055H$	+0.2	$-0.00044H$
April, 1919	12	−0.8	3	$-0.00041H$	......	−0.7	......	$-0.00059H$	+0.1	$-0.00018H$
Oct., 1919	18	−0.4	4	$-0.00075H$	......	−0.7	......	$-0.00064H$	−0.3	$+0.00011H$
June, 1920	12	−0.8	3	$-0.00076H$	......	−0.7	......	$-0.00070H$	+0.1	$+0.00006H$
Oct., 1920	20	−0.6	6	$-0.00076H$	......	−0.7	......	$-0.00073H$	−0.1	$+0.00003H$
May, 1921	......	......	......	....	13	−0.77	6	$-0.00078H$	......	....
June,[2] 1921 } July, 1921 }	......	......	......	....	12	−0.54	6	$-0.00077H$[3]	......	....
Weighted mean value of (I. M. S. at Washington—I. M. S. at Agincourt)..									−0.04	$-0.00001H$

[1] Values for 1916 to 1920 interpolated linearly between observed values for 1915 and 1921.
[2] After minor repairs.
[3] Referred to 1915 value of moment of inertia of long magnet and stirrup.

SUMMARY.

The above results confirm the published results as given in Volume II[a] of previous comparisons in declination and horizontal intensity, particularly so as the previous comparisons were without exchange of stations and, therefore, are not corrected for small station-differences. In view of the uncertainties involved in the transfer of dip-circle standards to that of the inductor because of the considerably greater precision of the inductor and lack of knowledge of station-differences at Agincourt between stations used in the earlier work, the results from the comparison at Washington are accepted for inclination.

Thus we adopt from the above:

(1) I. M. S. — Agincourt (Toronto declinometer) = $-1'.3$ (1906–1915).
(1*a*) I. M. S. — Agincourt (Elliott magnetometer No. 98) = $+0.00039H$ (1911–1915).
(1*b*) I. M. S. — Agincourt (Toepfer inductor No. 89) = $-0'.15$ at pier E (1912–1921).
(1*c*) I. M. S. — Agincourt (Toronto declinometer at pier $A - 0'.9$) = $0'.0$ at pier E (1916–1921).
(1*d*) I. M. S. — Agincourt (Elliott magnetometer No. 98 at pier $E + 0.00039H = 0.00000H$ (1916–1921).
(1*e*) I. M. S. — Meteorological Service (C. I. W. magnetometer No. 15) = $-0'.9$ (1915).
(1*f*) I. M. S. — Meteorological Service (C. I. W. magnetometer No. 15) = $+0.00007H$ (1915).

[a] See *Res. Dep. Terr. Mag.*, Vol. II, pp. 213–216.

NO. 2.—CHELTENHAM OBSERVATORY, MARYLAND.

SERIES I, 1915.

The comparisons of June 10 to 23, 1915, were made by H. W. Fisk at the Cheltenham Observatory of the United States Coast and Geodetic Survey, using C. I. W. magnetometer-inductor No. 26. Before taking this instrument to Cheltenham, careful comparisons were made at the Standardizing Magnetic Observatory of the Department of Terrestrial Magnetism in Washington between it and C. I. W. standard magnetometer No. 3 in declination and horizontal intensity, and between it and C. I. W. standard Schulze earth-inductor No. 48. Upon the conclusion of the work at Cheltenham, similar intercomparisons were again made at Washington. The standards of the Observatory are the large Wild-Edelmann instruments, consisting of declinometer, earth inductor, and magnetometer, No. 26.[a] The declinometer mounted on *declinometer pier*, with large theodolite for determining declination, and the earth inductor mounted on pier A, with its galvanometer for determining inclination, are in the east wing of the absolute house of the Observatory, while the magnetometer for determining horizontal intensity mounted on pier B is in the west wing. The observations for the three series were carried out between June 2 and July 2, 1915. The I. M. S. values given in the tables are based upon the corrections finally adopted for C. I. W. magnetometer-inductor No. 26.

The declination comparisons at Cheltenham were made with C.I.W. No. 26 mounted on pier B_i in the west wing of the absolute observatory, and were strictly simultaneous with observations with the C. & G. S. standard declinometer No. 26 in the east wing. The new Observatory mark from B_i, a cross painted on chimney of Hill's house, was used; its azimuth as supplied by the Observatory is 68° 26′.7. The mark, cupola on Hill's barn, used in previous comparisons has been altered because of settling. Additional declination comparisons were obtained with C. I. W. No. 26 set up in a tent at an outside station (designated O), aligned between the theodolite in the east wing and its mark, the cross painted on one of the brick buildings of the House of Reformation.[b]

In horizontal intensity the observations could not be simultaneous owing to the proximity of the pier B_i, used for the C. I. W. instrument, to the pier B on which the Observatory instrument is permanently mounted. Each determination with one instrument was followed immediately by a determination with the other. The corrections to the mean times of the C. I. W. observations on account of diurnal variation have been made from the magnetograph traces. In this manner 9 independent H-differences were found, 3 for each foot-screw orientation of C. I. W. No. 26.

The inclination comparisons were made with C. I. W. No. 26 on pier B_i and Wild-Edelmann inductor No. 26 on its own pier A in the east wing, the observations being as nearly simultaneous as the different forms of instrument would permit. During the first part of the inclination comparison the work was not begun until 10:30 a. m. in order that the declination might approximate that for which the Observatory earth-inductor was adjusted. To determine whether any station-difference had developed since the test of 1908, a non-magnetic framework was attached to the pier on which the Observatory instrument is mounted. C. I. W. No. 26 was placed on this frame as close to the coil of the Cheltenham inductor as possible (this station is designated $(EI)'$ in the tabulation of results). Ten sets with each instrument were obtained, as nearly

[a] The C. I. W. instrument is also numbered 26, and is distinguished from the Observatory instrument by the designation C. I. W. No. 26.

[b] In azimuth, 245° 11′.5; O is 35.9 feet (10.94 meters) nearly due east from the declinometer pier.

simultaneous as the condition under which the work was done would permit. The test shows no reason to suspect a station-difference.

TABLE 2A.—*Results of Declination Comparisons at the Cheltenham Observatory, 1915.*

Date	Local mean time		Declination obtained[1]		I. M. S.—Cheltenham	Remarks
	From	To	I. M. S.	Cheltenham		
1915	h m	h m	° ′	° ′	′	
June 10	14 17	14 26	−6 07.6	−6 07.5	−0.1	C. I. W. magnetometer No. 26 at B_i; C. & G. S. magnetometer No. 26 at *declinometer pier.*
10	16 58	17 07	03.4	03.1	−0.3	
11	9 02	9 11	00.6	00.2	−0.4	
11	13 56	14 05	07.0	06.4	−0.6	
11	14 35	14 46	06.5	06.1	−0.4	
11	15 26	15 35	06.0	05.1	−0.9	
12	9 39	9 48	04.2	03.6	−0.6	
12	11 41	11 50	11.7	11.4	−0.3	
12	13 22	13 31	12.2	11.3	−0.9	
12	14 47	14 56	10.0	09.6	−0.4	
14	9 18	9 27	01.9	01.6	−0.3	
14	10 55	11 04	05.1	04.6	−0.5	
14	11 30	11 39	05.7	05.4	−0.3	
14	15 23	15 32	07.4	07.0	−0.4	
14	15 37	15 46	07.2	06.7	−0.5	
14	16 33	16 42	05.7	05.3	−0.4	
15	9 00	9 09	−5 59.7	−5 59.4	−0.3	
15	15 06	15 15	−6 09.4	−6 09.2	−0.2	
22	13 47	13 56	05.8	05.5	−0.3	C. I. W. magnetometer No. 26 at *O;* C. & G. S. magnetometer No. 26 at *declinometer pier.*
22	14 02	14 11	05.9	05.5	−0.4	
22	14 31	14 40	06.7	06.4	−0.3	
22	14 45	14 54	07.5	07.0	−0.5	
22	16 21	16 30	06.5	06.6	+0.1	
22	16 36	16 45	05.8	05.9	+0.1	
22	17 09	17 18	05.2	05.1	−0.1	
Mean value of (I. M. S.—Cheltenham)...........					−0.37	

[1] Station-differences are negligible.

TABLE 2B.—*Results of Horizontal-Intensity Comparisons at the Cheltenham Observatory, 1915.*

Date	Local mean time		Hor. int. obtained[1]		I. M. S.—Cheltenham	Remarks
	From	To	I. M. S.	Cheltenham[2]		
1915	h m	h m	γ	γ	γ	
June 10	14 31	16 12	19446	19447	−1	C. I. W. magnetometer No. 26 at B_i throughout; C. & G. S. magnetometer No. 26 at *B* throughout. Observations could not be made simultaneously with the 2 instruments, the piers being too close together.
11	7 09	8 37	416	423	−7	
11	10 37	11 58	416	421	−5	
12	7 34	9 19	421	419	+2	
12	12 01	13 14	434	434	0	
14	7 27	8 53	398	397	+1	
14	13 27	15 13	430	432	−2	
15	7 18	8 43	424	428	−4	
15	11 05	11 46	422	429	−7	
15	14 01	14 47				
Mean value of (I. M. S.—Cheltenham)....					−2.6γ or −0.00013*H*	

[1] Station-difference is negligible.

[2] Values as observed by C. & G. S. magnetometer 26 are reduced to mean times of observation with C. I. W. No. 26, corrections being determined from magnetogram scalings.

SERIES II, 1917.

During January 2 to 5, 1917, inclination comparisons were obtained at the Cheltenham Observatory of the U. S. Coast and Geodetic Survey by Mr. G. Hartnell, Observer-in-Charge of the Observatory, and Mr. H. R. Schmitt of the Carnegie Institution of Washington. The observations with the Observatory instrument were made on pier *A*, used regularly for absolute determinations of inclination, in the east wing of the absolute house. The extra pier, B_i, in the west wing of the absolute house was

TABLE 2C.—*Results of Inclination Comparisons at the Cheltenham Observatory, 1915.*

Date	Local mean time		Inclination obtained[1]		I. M. S.—Cheltenham	Remarks
	From	To	I. M. S.	Cheltenham		
1915	h m	h m	° ′	° ′	′	
June 16	10 34	10 49	+70 49.7	+70 48.6	+1.1	C. I. W. inductor No. 26 at B_i; C. & G. S. inductor No. 26 at A.
16	11 01	11 14	49.5	48.3	+1.2	
16	11 22	11 35	48.7	47.1	+1.6	
16	11 46	11 57	48.8	46.9	+1.9	
16	13 48	14 01	47.8	45.8	+2.0	
16	14 18	14 32	48.0	46.1	+1.9	
16	14 57	15 09	48.2	46.1	+2.1	
16	15 17	15 27	48.0	45.9	+2.1	
16	16 17	16 30	47.9	46.1	+1.8	
16	16 40	16 53	47.6	46.1	+1.5	
18	13 24	13 43	51.4	50.0	+1.4	
18	13 52	14 05	51.2	49.7	+1.5	
18	14 22	14 35	51.2	49.2	+2.0	
18	14 46	15 00	50.9	49.2	+1.7	
18	15 30	15 43	49.8	48.6	+1.2	
18	16 03	16 16	49.5	48.3	+1.2	
18	16 25	16 38	49.1	47.9	+1.2	
19	10 22	10 35	51.0	50.3	+0.7	
19	10 53	11 07	50.9	49.8	+1.1	
19	13 20	13 35	50.2	48.4	+1.8	
19	13 52	14 08	49.6	48.0	+1.6	
19	15 47	16 14	49.0	47.6	+1.4	C. I. W. inductor No. 26 at $(EI)'$; C. & G. S. No. 26 at A. These observations were made alternately with the 2 instruments, the inductor coils being too close together to allow of simultaneous rotation.
19	16 46	17 04	48.9	47.7	+1.2	
21	8 50	9 09	50.8	49.6	+1.2	
21	9 28	9 49	50.2	49.1	+1.1	
21	9 55	10 16	50.0	49.4	+0.6	
21	10 27	10 49	50.3	48.8	+1.5	
21	13 54	14 23	47.1	45.3	+1.8	
21	14 42	15 03	47.4	45.0	+2.4	
21	15 25	15 48	47.8	45.4	+2.4	
21	16 41	17 01	47.9	46.1	+1.8	
22	9 45	10 08	50.6	49.8	+0.8	C. I. W. inductor No. 26 at B_i; C. & G. S. inductor No. 26 at A.
23	13 47	14 00	48.8	47.1	+1.7	
23	14 14	14 27	48.6	47.2	+1.4	
23	14 53	15 05	47.8	46.8	+1.0	
23	15 22	15 32	48.0	47.0	+1.0	
23	15 54	16 06	48.3	47.0	+1.3	
23	16 20	16 34	48.3	47.1	+1.2	
Mean value of (I. M. S.—Cheltenham)....					+1.5	

[1] Station-differences are negligible.

used for the C.I.W. observations. The determinations with the two instruments mounted at A and B_i were simultaneous. To determine whether any station-difference existed between the piers A and B_i, a special, non-magnetic, wooden framework was attached to pier A, and the C.I.W. instrument was placed on this frame as closely as possible to the coil of the Cheltenham inductor. This auxiliary station was designated $(EI)'$. Since the instruments when mounted on A and on $(EI)'$ could not be operated simultaneously, each complete determination with C. and G. S. No. 26 was made between the two half-determinations with C.I.W. No. 26; the mean values thus apply practically for the same mean times. The results from the observations at A and $(EI)'$ indicate, as in June 1915, that the station-differences between A and B_i and between A and $(EI)'$ are for all practical purposes negligible. The three stations were those occupied in June 1915; the stations A and B_i were also occupied for the comparisons during 1908–1913.[a]

The standard inclination-instrument at the Observatory is, as heretofore,[a] Wild-Edelmann earth inductor No. 26. It has been overhauled, however, and somewhat modified since the comparisons of June 1915, and is now so mounted that the axis of

[a] See *Res. Dep. Terr. Mag.*, Vol. II, pp. 226–228.

rotation may be precisely oriented in the magnetic meridional plane for each observation. The C.I.W. instrument used was the inductor attachment of magnetometer-inductor C.I.W. No. 26. The correction on International Magnetic Standard[a] for C.I.W. No. 26 was −0′.1, dip of the north-seeking end of the needle below the horizon being reckoned as positive.

On January 4, observations were discontinued because of a severe magnetic storm. The first observations with C.I.W. No. 26 on the morning of January 5 were erratic, probably because of slight looseness of the coil in its bearings, and have been omitted, therefore, in Table 2D.

TABLE 2D.—*Results of Inclination Comparisons at the Cheltenham Observatory, 1917.*

Date	Local mean time		Inclination obtained[1]		I. M. S.—Chelten-ham	Remarks
	From	To	I. M. S.	Cheltenham		
1917	h m	h m	° ′	° ′	′	
Jan. 2	9 45	10 00	+70 52.1	+70 51.7	+0.4	
2	10 26	10 38	52.9	52 4	+0.5	
2	11 01	11 11	53.3	52.6	+0.7	
2	11 20	11 29	53.4	52.7	+0.7	
2	11 51	12 02	53.2	52.6	+0.6	
2	13 26	13 37	52.7	51.7	+1.0	C. I. W. No. 26 at B_1; C. and G. S. No. 26 at *A*.
2	13 57	14 06	52.4	51.4	+1.0	
2	14 19	14 29	52.9	52.1	+0.8	
2	15 00	15 09	52.7	51.7	+1.0	
2	15 24	15 33	52.4	51.2	+1.2	
2	15 43	15 54	52.3	51.2	+1.1	
2	16 08	16 19	52.0	50.7	+1.3	
3	9 55	10 37	53.2	51.8	+1.4	
3	10 43	11 13	53.1	52.0	+1.1	C. I. W. No. 26 at $(EI)'$; C. and G. S. No. 26 at *A*. The observations were made alternately with the instruments; the resulting values for (I. M. S.—Cheltenham) are weighted 0.5 in the mean.
3	11 21	11 46	52.9	52.2	+0.7	
3	12 23	12 48	52.6	51.8	+0.8	
3	13 00	13 31	52.4	51.3	+1.1	
3	13 49	14 17	52.0	50.9	+1.1	
3	14 42	15 09	51.4	50.5	+0.9	
3	15 12	15 36	50.8	50.2	+0.6	
3	15 46	16 07	51.3	50.0	+1.3	
3	16 13	16 35	51.3	50.1	+1.2	
5	11 28	11 41	55.6	55.0	+0.6	
5	11 50	11 59	55.6	54.8	+0.8	
5	12 10	12 19	55.6	55.0	+0.6	
5	12 27	12 38	55.6	54.9	+0.7	
5	13 51	14 00	55.2	54.6	+0.6	
5	14 10	14 18	54.4	53.8	+0.6	C. I. W. No. 26 at B_1; C. and G. S. No. 26 at *A*.
5	14 29	14 37	54.2	53.7	+0.5	
5	14 58	15 06	54 2	53.5	+0.7	
5	15 25	15 34	53.8	53.2	+0.6	
5	15 41	15 49	53.8	53.2	+0.6	
5	15 59	16 08	53.9	53.1	+0.8	
5	16 14	16 22	53.9	53.2	+0.7	
	Weighted mean value of (I. M. S.—Cheltenham)				+0.8	

[1] It is assumed that the station-differences are negligible.

SERIES III, 1918.

This series results indirectly through the comparison during March 12 to 16, 1918, of Cooke magnetometer No. 40, property of the United States Coast and Geodetic Survey, with C.I.W. standard magnetometer No. 3 at Washington, D. C., and its comparison during February 13 to 27, 1918, with C. & G. S. standard magnetometer No. 26 at the Cheltenham Observatory. At Cheltenham the mean from 12 direct comparisons in declination on February 18 and 25 was:

(*a*) Cheltenham − C. & G. S. No. 40 = −0′.21,

[a] See *Res. Dep. Terr. Mag.*, Vol. II, pp. 270–273.

while the mean from 12 comparisons through the magnetograph on February 13, 14, 19, 25, and 27 was:

(*b*) Cheltenham − C. & G. S. No. 40 = +0.00018*H*.

The comparisons during March at Washington were made by the method of simultaneous observations and exchange of stations at piers N_m and S_m of the Standardizing Magnetic Observatory, Mr. H. W. Fisk observing with C.I.W. magnetometer No. 3 and Mr. W. W. Merrymon, of the Coast Survey staff, with C. & G. S. magnetometer No. 40. The result of the 12 comparisons in declination was:

(*c*) I. M. S. − C. & G. S. No. 40 = −0′.16,

while from 6 complete sets in horizontal intensity it was found that

(*d*) I. M. S. − C. & G. S. No. 40 = +0.00002*H*.

From (*a*) and (*c*) and (*b*) and (*d*) we get

(*e*) I. M. S. − Cheltenham = +0′.05, and
(*f*) I. M. S. − Cheltenham = −0.00016*H*.

SUMMARY.

Table 2E summarizes the chief results as already published in Volume II[a] and as given above (horizontal-intensity results prior to 1913 are referred to basis of C. & G. S. standard adopted beginning with 1913,[b] viz, standard previously used diminished by 0.001*H*).

TABLE 2E.—*Summary of Corrections on Standards for Cheltenham Observatory.*

Date	(I. M. S.—Cheltenham)					
	Declination	Weight	Hor. int.[1]	Weight	Inclination	Weight
	′				′	
1908, Feb.	+0.18	1.0	−0.00007*H*	1.0	+0.9	0.5
1908, Mar.	−0.18	1.0	−0.00008*H*	1.0	+0.5	3.0
1910, Apr.	+0.06	1.0	+0.00013*H*	0.5	+0.5	1.0
1913, Nov.	+0.22	1.5	+0.00001*H*	2.0	+1.5[2]	1.0
1915, Jun.	−0.37	1.5	−0.00013*H*	1.5	+1.5[2]	1.0
1917, Jan.	......	...	....	...	+0.8	1.5
1918, Feb.-Mar.	+0.05	1.0	−0.00016*H*	1.0	.....	...

[1] Referred to standard for horizontal intensity adopted by the Coast and Geodetic Survey beginning with 1913.

[2] These results given small weight because the axis of rotation of Wild-Edelmann inductor No. 26 could not be precisely oriented in the magnetic meridional plane for each observation (see remarks Series II, 1917).

Hence we obtain weighted mean values as follows:

(2) I. M. S. − Cheltenham (Wild-Edelmann declinometer No. 26) = 0′.0 (1908–1918).

(2*a*) I. M. S. − Cheltenham (Wild-Edelmann magnetometer No. 26) = −0.00006*H* (1908–1918).[c]

(2*b*) I. M. S. − Cheltenham (Wild-Edelmann inductor No. 26) = +0′.9 (1908–1917).[d]

[a] See *Res. Dep. Terr. Mag.*, Vol. II, pp. 226–229.

[b] See Faris, R. L., Results of Magnetic Observations Made by U. S. C. & G. S. in 1913, Washington, 1914, pp. 1–52.

[c] See foot-note 1 to Table 2E.

[d] Director E. Lester Jones of the Coast and Geodetic Survey in a letter dated January 15, 1917, states that C. & G. S. Schulze earth-inductor No. 1, from the Porto Rico magnetic observatory, had been compared recently at Cheltenham after receiving a thorough overhauling in the instrument-shop. The preliminary results of these observations gave (Cheltenham—C. & G. S. No. 1) = −0′.8 as compared with value −1′ derived from comparison observations made in 1904; this indicates excellent maintenance of inclination standard at Cheltenham between 1904 and 1917. Using (I. M. S.—Cheltenham) = +0′.8 the correction for Schulze inductor C. & G. S. No. 1 on I. M. S. would be thus 0′.0.

NO. 3.—CHRISTCHURCH OBSERVATORY, NEW ZEALAND.

Series I, III, and V of comparisons at the Christchurch Observatory in November 1915, in April 1916, and in October to November 1920, were obtained during the visits of the magnetic-survey vessel *Carnegie* to Port Lyttelton, Messrs. H. M. W. Edmonds and I. A. Luke observing for series I and III, and Messrs. H. F. Johnston and H. R. Grummann observing for series V, with the C. I. W. instruments; series II was obtained in December 1915 by Observer H. E. Sawyer; series IV was obtained during February, April, and May 1916 by Observer W. C. Parkinson. Simultaneous observations with the Observatory absolute-instruments were made only for series I and V, for inclination comparisons of May 1916 in series IV, Director H. F. Skey observing throughout. Four stations were used, viz, the east and west piers of the absolute house and the stations designated by the Observatory authorities as *jarrah peg* and *brass pipe*. These were the stations occupied for the comparisons during 1906–1908,[a] the station *jarrah peg* being the same as the station previously designated *peg A*. The *east pier* in the absolute house is used regularly for the Observatory absolute-observations of declination and horizontal intensity while the *west pier* in the absolute house is used regularly for the Observatory absolute-observations of inclination. There is a small wooden pier to the north of *west pier*, on which the galvanometer is mounted. The station *jarrah peg* is 12.14 meters and 14.10 meters from the northeast and northwest corners of the absolute house respectively. The station *brass pipe* is 21.70 meters north of east from the station *jarrah peg*. The azimuth mark, designated Rm_1, used for the east pier was a piece of wood covered with white cloth in a 2-inch iron pipe to the east of north of the west end of a small lake known as Victoria Lake; its true bearing from *east pier* is 196° 09′.0 west of south and from *jarrah peg* is 196° 03′.8 west of south. A similar mark, designated Rm_2, on the south bank of the west end of Victoria Lake was used for the station *jarrah peg*; its true bearing from that station is 200° 13′.3 west of south. The mark Rm_2 was also used for the station *brass pipe*; its true bearing from that station is 195° 14′.2 west of south. The true bearings were supplied by Director Skey.

The Observatory absolute-instruments used for series I and V were magnetometer No. 1, manufactured by the Cambridge Scientific Instrument Company, for declination and horizontal intensity, and earth inductor No. 109, manufactured by Toepfer and Son, for inclination. The Christchurch values for series II and III depend upon the magnetograph data which in turn are based upon absolute observations made with the above instruments at the stations regularly used by the Observatory. The C. I. W. instruments used were magnetometer No. 5 and magnetometer-inductor No. 25 for series I, III, and V, magnetometer No. 17 and Dover dip circle No. 223 with needles 1, 3, 5, and 6 for series II, universal magnetometer No. 14 with needles 1, 2, 5, and 6, and dip circle No. 201 with needles 1X, 2X, 3X, and 4X for series IV. The corrections on International Magnetic Standards[b] applied to results obtained with the C.I.W. instruments were those finally adopted. Some observations were also made during series I and III with C.I.W. marine inductor No. 3; the results, however, were not utilized since this instrument was then, because of wear arising from long use on board ship, less satisfactory for land work than the inductor attachment of magnetometer-inductor No. 25.

All the observations were interfered with to some extent by disturbances caused by electric-tram lines. There is a tramway about one-quarter mile west of south of the Observatory which has comparatively infrequent service, another about one-half

[a] See *Res. Dep. Terr. Mag.*, Vol. II, pp. 229–231.
[b] See *Res. Dep. Terr. Mag.*, Vol. II, pp. 270–278.

mile to the southeast with very frequent service, and a third somewhat farther away to the northward with very frequent service. The tram lines occasion noticeable effects at the observing stations. For this reason the inductor comparisons of November 1920 were carried out in part at night when the trams were not operating. The station-differences determined in 1915 and 1920 show fairly good agreement; the values used are given in the foot-notes to the tables of results. Director Skey in June 1921 when supplying the final values for the Observatory states that the declination base-line values resulting from the absolute observations on November 9, 10, 11, 12, and 15, 1915, indicated *east pier* = *jarrah peg* − 0′.27 = *brass pipe* + 0′.61; the simultaneous absolute observations with the three magnetometers in November 1915 gave *east pier* = *jarrah peg* − 0′.48 = *brass pipe* + 0′.54, while those with the two magnetometers in November 1920 gave *east pier* = *jarrah peg* − 0′.26. The station-differences adopted for all of the declination work were those indicated by the mean of the above results, viz, *east pier* = *jarrah peg* − 0′.3 = *brass pipe* + 0′.6.

TABLE 3A.—*Results of Declination Comparisons at the Christchurch Observatory, 1915, 1916, and 1920.*

Series	Date	Local mean time		Declination obtained[1]		I. M. S.—Christchurch	Remarks
		From	To	I. M. S.	Christchurch		
	1915	h m	h m	° ′	° ′	′	
I	Nov. 9	8 54	9 05	+16 39.2	+16 39.8	−0.6	C. I. W. No. 5 at *brass pipe;* C. I. W. No. 25 at *jarrah peg;* Christchurch No. 1 at *east pier.*
	9	11 45	11 56	48.3	47.6	+0.7	
	10	8 36	8 47	42.5	41.2	+1.3	
	10	10 54	11 05	44.5	44.4	+0.1	
	10	11 39	11 50	45.8	45.4	+0.4	
	10	12 00	12 11	47.2	47.0	+0.2	
	10	15 10	15 21	51.9	51.4	+0.5	C. I. W. No. 5 at *east pier;* C. I. W. No. 25 at *brass pipe;* Christchurch No. 1 at *jarrah peg.*
	11	9 55	10 06	43.6	43.2	+0.4	
	11	14 23	14 34	51.7	51.3	+0.4	
	11	19 49	15 00	52.2	51.8	+0.4	
	12	8 58	9 09	40.7	40.9	−0.2	C. I. W. No. 5 at *jarrah peg;* C. I. W. No. 25 at *east pier;* Christchurch No. 1 at *brass pipe.*
	12	11 50	12 01	47.9	47.5	+0.4	
	15	8 47	8 58	42.6	41.8	+0.8	
	15	11 04	11 15	46.8	45.3	+1.5	
	15	11 50	12 01	48.2	47.1	+1.1	
	15	12 11	12 22	49.0	48.1	+0.9	
	15	17 58	18 09	49.8	48.5	+1.3	C. I. W. No. 5 at *east pier;* C. I. W. No. 25 at *brass pipe;* Christchurch No. 1 at *jarrah peg.*
	15	18 12	18 23	49.1	47.6	+1.5	
					Mean	+0.6	(weight, 3)
II	Dec. 21	11 20	11 29	+16 47.2	+16 46.4	+0.8	C. I. W. No. 17 at *east pier.*[2]
	21	13 24	13 33	52.9	52.9	0.0	
	21	13 58	14 07	53.6	53.1	+0.5	
	21	15 36	15 45	54.7	52.9	+1.8	
	21	16 00	16 09	53.1	52.7	+0.4	
	21	17 55	18 04	51.2	50.6	+0.6	
	22	13 54	14 03	52.0	53.0	−1.0	
	22	15 37	15 46	52.7	52.4	+0.3	
	22	16 09	16 18	52.2	51.8	+0.4	
	22	17 56	18 05	50.2	50.5	−0.3	
	24	4 18	4 27	46.2	45.7	+0.5	
	24	7 06	7 15	43.8	43.2	+0.6	
					Mean	+0.4	(weight, 1)

[1] All values are referred to *east pier* using the mean station-differences determined from the comparisons of November 1915 and of November 1920, viz, *east pier*=*jarrah peg*−0′.3=*brass pipe* +0′.6 (see above).

[2] The Christchurch values are from the magnetograms which apply for *east pier*.

TABLE 3A.—*Results of Declination Comparisons at the Christchurch Observatory, 1915, 1916, and 1920*—Concluded.

Series	Date	Local mean time From	Local mean time To	Declination obtained[1] I. M. S.	Declination obtained[1] Christ-church	I. M. S.—Christ-church	Remarks
	1916	h m	h m	° ′	° ′	′	
III	Apr. 4	11 39	11 47	+16 49.5	+16 50.2	−0.7	C. I. W. No. 5 at *brass pipe;* C. I. W. No. 25 at *jarrah peg.*[2]
	4	16 32	16 40	50.7	51.2	−0.5	
	5	11 56	12 04	50.9	51.4	−0.5	
	5	12 14	12 22	51.1	52.0	−0.9	
	5	14 05	14 13	52.8	53.7	−0.9	
	5	16 15	16 23	50.5	51.0	−0.5	
	6	11 55	12 03	51.3	51.7	−0.4	C. I. W. No. 5 at *jarrah peg;* C. I. W. No. 25 at *brass pipe.*[2]
	6	15 00	15 08	54.4	54.8	−0.4	
	6	15 22	15 30	53.5	54.0	−0.5	
	7	10 11	10 19	45.2	45.7	−0.5	
	7	10 34	10 42	46.4	46.6	−0.2	
	7	12 24	12 32	52.3	52.5	−0.2	
	17	14 09	14 17	51.1	51.8	−0.7	C. I. W. No. 5 at *brass pipe;* C. I. W. No. 25 at *jarrah peg.*[2]
	17	16 08	16 16	49.3	49.8	−0.5	
					Mean	−0.5	(weight, 2)
IV	Feb. 27	5 59	6 06	+16 47.0	+16 46.8	+0.2	C. I. W. No. 14 at *east pier.*[2]
	27	10 40	10 47	48.6	47.5	+1.1	
	27	12 01	12 08	50.8	51.0	−0.2	
	Apr. 9	10 43	10 50	46.8	46.7	+0.1	
	9	12 47	12 54	52.2	52.1	+0.1	
					Mean	+0.3	(weight, 1)
	1920						
V	Nov. 3	12 44	12 53	+17 06.3	+17 06.0	+0.3	C. I. W. No. 5 at *east pier;* Christchurch No. 1 at *jarrah peg.*
	3	12 57	13 06	06.6	06.4	+0.2	
	3	14 35	14 48	06.4	07.0	−0.6	
	3	14 49	15 02	07.0	07.3	−0.3	
	3	15 47	16 00	05.8	05.8	0.0	
	3	16 01	16 14	05.3	05.4	−0.1	
	4	14 47	14 56	07.8	08.2	−0.4	C. I. W. No. 5 at *jarrah peg;* Christchurch No. 1 at *east pier.*
	4	14 57	15 06	08.3	08.1	+0.2	
	4	15 21	15 30	07.8	08.0	−0.2	
	4	15 31	15 40	08.0	08.5	−0.5	
	4	15 50	15 59	08.8	08.8	0.0	
	4	16 00	16 09	08.3	08.4	−0.1	
					Mean	−0.1	(weight, 2)
Weighted mean value of (I. M. S.—Christchurch) from I, II, III, IV, and V..............................						+0.1	

[1] All values are referred to *east pier* using the mean station-differences determined from the comparisons of November 1915 and of November 1920, viz, *east pier*=*jarrah peg*$-0'.3$=*brass pipe*$+0'.6$ (see page 409).

[2] The Christchurch values are from the magnetograms which apply for *east pier*.

TABLE 3B.—*Results of Horizontal-Intensity Comparisons at the Christchurch Observatory, 1915, 1916, and 1920.*

Series	Date	Local mean time		Hor. int. obtained[1]		I. M. S.—Christ-church	Remarks
		From	To	I. M. S.	Christ-church		
	1915	*h m*	*h m*	γ	γ	γ	
I	Nov. 8	14 26	16 24	22401	22376	+25	C. I. W. No. 5 at *brass pipe;* C. I. W. No. 25 at *jarrah peg;* Christchurch No. 1 at *east pier.*
	9	9 15	11 04	340	335	+ 5	
	10	8 58	10 41	356	343	+13	
	10	15 33	17 29	412	398	+14	C. I. W. No. 5 at *east pier;* C. I. W. No. 25 at *brass pipe;* Christchurch No. 1 at *jarrah peg.*
	11	10 21	12 26	365	331	+34	
	11	15 15	16 51	408	390	+18	
	12	9 12	11 17	359	348	+11	C. I. W. No. 5 at *jarrah peg;* C. I. W. No. 25 at *east pier;* Christchurch No. 1 at *brass pipe.*
	15	9 08	10 52	376	359	+17	
	15	15 47	17 32	423	396	+27	
					Mean	+18.2γ or +0.00081*H* (weight, 3)	
II	Dec. 21	11 32	13 20	22369	22373	− 4	C. I. W. magnetometer No. 17 at *east pier.*[2]
	21	14 10	15 33	400	393	+ 7	
	21	16 12	17 51	424	410	+14	
	22	14 09	15 35	412	397	+15	
	22	16 20	17 54	412	406	+ 6	
	24	5 34	7 02	408	394	+14	
					Mean	+ 8.7γ or +0.00039*H* (weight, 1)	
	1916						
III	Apr. 4	11 58	16 30	22372	22347	+25	C. I. W. No. 5 at *brass pipe;* C. I. W. No. 25 at *jarrah peg.*[2]
	5	10 04	11 52	347	335	+12	
	5	14 15	16 12	376	364	+12	
	6	12 06	14 58	380	360	+20	C. I. W. No. 5 at *jarrah peg;* C. I. W. No. 25 at *brass pipe.*[2]
	7	9 21	10 10	339	336	+ 3[3]	
	7	10 44	12 22	356	334	+22	
	17	14 18	16 05	385	363	+22	C. I. W. No. 5 at *brass pipe;* C. I. W. No. 25 at *jarrah peg.*[2]
					Weighted mean	+17.6γ or +0.00079*H* (weight, 2)	
IV	Feb. 27	6 10	8 03	22382	23378	+ 4	C. I. W. No. 14 at *east pier.*[2]
	27	10 50	11 40	333	336	− 3[3]	
	Apr. 9	10 56	12 46	344	345	− 1	
					Weighted mean	+0.6γ or +0.00003*H* (weight, 0.0)	
	1920						
V	Oct. 29	12 14	15 03	22272	22262	+10	C. I. W. No. 5 at *jarrah peg;* Christchurch No. 1 at *east pier.*
	29	15 13	15 56	273	250	+23	
	30	9 54	10 35				
	30	10 47	12 42	251	231	+20	
	Nov. 2	10 30	12 41	266	247	+19	
	2	14 23	15 52	284	262	+22	C. I. W. No. 5 at *east pier;* Christchurch No. 1 at *jarrah peg.*
	2	16 02	16 50	266	255	+11	
	3	10 33	11 19				
					Mean	+17.5γ or +0.00079*H* (weight, 2)	
Weighted mean value of (I. M. S.—Christchurch) from I, II, III, IV, and V..................................						+16.7γ or +0.00075*H*	

[1] Values for 1915 to 1916 are referred to *east pier*, using the station-differences determined in November 1915, viz, *east pier*=*brass pipe*+1.3γ=*jarrah peg*+5.5γ; values for 1920 are referred to *east pier*, using the station-difference then determined, viz, *east pier*=*jarrah peg*+3.8γ.

[2] The Christchurch values are from the magnetograms which apply for *east pier*.

[3] Half set; weight 0.5.

TABLE 3C.—*Results of Inclination Comparisons at the Christchurch Observatory, 1915, 1916, and 1920.*

Series	Date	Local mean time From	Local mean time To	Inclination obtained[1] I. M. S.	Inclination obtained[1] Christ-church	I. M. S.—Christ-church	Remarks
	1915	h m	h m	° ′	° ′	′	
I	Nov. 7	6 03	6 16	−68 03.9	−68 03.8	−0.1	
	7	6 29	6 42	04.0	04.1	+0.1	
	7	6 54	7 13	03.9	03.8	−0.1	
	7	7 28	7 38	04.0	04.7	+0.7	
	7	7 48	8 02	04.4	04.9	+0.5	C. I. W. No. 25 at *jarrah peg;* Christchurch No. 109 at *west pier.*
	7	8 12	8 22	04.6	05.2	+0.6	
	7	8 32	8 44	05.3	05.9	+0.6	
	7	9 01	9 16	05.4	06.0	+0.6	
	7	9 29	9 39	05.5	06.0	+0.5	
	7	9 49	10 02	05.5	05.9	+0.4	
	14	6 10	6 24	02.3	02.5	+0.2	
	14	6 35	6 49	01.9	01.2	−0.7	
	14	6 59	7 10	00.1	01.6	+1.5	
	14	7 18	7 30	00.0	01.7	+1.7	
	14	7 46	7 58	01.2	02.0	+0.8	
	14	8 04	8 14	01.3	02.0	+0.7	C. I. W. No. 25 at *west pier;* Christchurch No. 109 at *jarrah peg.*
	14	8 21	8 41	01.7	01.9	+0.2	
	14	8 46	8 54	01.8	02.0	+0.2	
	14	9 10	9 20	02.2	02.0	−0.2	
	14	9 30	9 39	02.1	02.2	+0.1	
	14	9 45	10 33	02.9	02.7	−0.2	
	14	10 44	10 53	02.5	02.8	+0.3	
					Mean	+0.4	(weight, 4)
II	Dec. 19	5 08	7 17	−68 02.9	−68 02.6	−0.3	
	19	8 08	9 45	04.4	03.9	−0.5	
	22	6 10	7 11	03.4	03.0	−0.4	C. I. W. No. 223 at *west pier.*[2]
	22	7 58	9 25	04.1	04.1	0.0	
	23	5 00	6 34	02.4	02.4	0.0	
	23	6 53	8 17	03.2	02.9	−0.3	
					Mean	−0.2	(weight, 1)
	1916						
III	Apr. 28	14 33	14 50	−68 05.8	−68 05.5	−0.3	
	28	14 54	15 10	05.8	05.8	0.0	
	28	15 19	15 37	06.9	07.4	+0.5	
	28	15 44	15 59	05.1	05.1	0.0	
	28	16 03	16 17	04.6	04.6	0.0	
	28	16 21	16 33	05.5	05.6	+0.1	
	29	9 20	9 35	04.6	04.4	−0.2	C. I. W. No. 25 at *brass pipe.*[2]
	29	9 46	9 59	04.9	04.7	−0.2	
	29	10 03	10 16	04.9	04.8	−0.1	
	29	10 21	10 34	05.4	05.3	−0.1	
	29	10 49	11 03	07.6	07.6	0.0	
	29	11 08	11 19	09.6	08.9	−0.7	
	29	11 28	11 41	11.2	10.3	−0.9	
	29	11 49	12 02	11.0	10.2	−0.8	
	May 2	8 36	8 48	05.5	03.9	−1.6	
	2	8 52	9 02	05.0	03.6	−1.4	
	2	9 07	9 17	05.2	03.8	−1.4	
	2	9 20	9 31	04.8	03.7	−1.1	
	2	9 45	9 57	04.2	03.6	−0.6	
	2	10 01	10 13	04.0	03.6	−0.4	
	2	10 28	10 40	03.7	03.4	−0.3	C. I. W. No. 25 at *jarrah peg.*[2]
	2	10 45	10 57	03.5	03.4	−0.1	
	2	10 59	11 12	02.8	03.2	+0.4	
	2	11 31	11 49	03.4	03.2	−0.2	
	2	11 54	12 05	03.7	03.3	−0.4	
	2	12 10	12 21	03.6	03.4	−0.2	
	2	12 27	12 39	03.7	03.6	−0.1	
					Mean	−0.4	(weight, 3)

[1] Values for 1915 and 1916 are referred to *west pier*, using the station-differences determined in November 1915, viz, *west pier*=*jarrah peg*+0′.23=*brass pipe*+0′.23; for the work of February 27 and April 11, 1916, it is assumed that any station-difference between *east pier* and *west pier* is negligible; values for 1920 are referred to *west pier*, using station-difference then determined, viz, *west pier*=*jarrah peg*+0′.01.

[2] The Christchurch values are from the magnetograms which apply for *west pier*.

TABLE 3C.—*Results of Inclination Comparisons at the Christchurch Observatory, 1915, 1916, and 1920*—Concluded.

Series	Date	Local mean time From	Local mean time To	Inclination obtained[1] I. M. S.	Inclination obtained[1] Christ-church	I. M. S.—Christ-church	Remarks
	1916	*h m*	*h m*	° ′	° ′	′	
IV	Feb. 27	14 30	15 42	−68 02.0	−68 02.3	+0.3	C. I. W. No. 14 at *east pier*.[2]
	Apr. 11	9 37	10 44	01.8	02.9	+1.1	
	May 7	7 41	8 35	05.3	03.9	−1.4	C. I. W. No. 201 at *jarrah peg;* Christchurch No. 109 at *west pier*.
	7	8 39	9 24	05.4	04.3	−1.1	
	7	9 27	10 16	05.6	04.5	−1.1	
					Mean	−0.4	(weight, 0.5)
	1920						
V	Oct. 31	6 27	6 44	−68 09.0	−68 08.3	−0.7	C. I. W. No. 25 at *jarrah peg;* Christchurch No. 109 at *west pier*.
	31	6 56	7 18	09.4	08.7	−0.7	
	31	7 33	7 55	09.8	09.2	−0.6	
	31	8 05	8 23	10.0	09.9	−0.1	
	31	8 28	8 49	10.8	09.8	−1.0	
	31	9 00	9 18	11.4	10.3	−1.1	
	Nov. 5	0 19	0 35	10.2	09.5	−0.7	C. I. W. No. 25 at *east pier;* Christchurch No. 109 at *jarrah peg*.
	5	0 44	0 55	10.3	09.7	−0.6	
	5	1 05	1 17	10.4	09.6	−0.8	
	5	1 26	1 39	10.8	10.0	−0.8	
	5	1 52	2 03	10.7	10.1	−0.6	
	5	2 10	2 23	11.0	10.2	−0.8	
					Mean	−0.7	(weight, 2)
Weighted mean value of (I. M. S.—Christchurch) from I, II, III, IV, and V.						−0.1	

[1] Values for 1915 and 1916 are referred to *west pier*, using the station-differences determined in November 1915, viz, *west pier*=*jarrah peg*+0′.23=*brass pipe*+0′.23; for the work of February 27 and April 11, 1916, it is assumed that any station-difference between *east pier* and *west pier* is negligible; values for 1920 are referred to *west pier*, using station-difference then determined, viz, *west pier*=*jarrah peg*+0′.01.

[2] The Christchurch values are from the magnetograms which apply for *west pier*.

SUMMARY.

Table 3D summarizes the chief results as already published in Volume II[a] and as given above.

TABLE 3D.—*Summary of Corrections on Standards for Christchurch Observatory.*

Date	(I. M. S.—Christchurch) Declination	Weight	Hor. int.	Weight	Inclination	Weight
	′				′	
1906, Jul.	+0.8	1.0	. . . .	. . .	−0.6[1]	1.0
1907, Dec. . . . . . / 1908, Jan.	+1.2	3.0	+0.00064*H*	2.0	−1.2[1]	1.0
1915, Nov.	+0.6	3.0	+0.00081*H*	3.0	+0.4	4.0
1915, Dec.	+0.4	1.0	+0.00039*H*	1.0	−0.2	1.0
1916, Apr.	−0.5	2.0	+0.00079*H*	2.0	−0.4	3.0
1916, Feb.–Apr. .	+0.3	1.0	+0.00003*H*	0.0	−0.4	0.5
1920, Nov.	−0.1	2.0	+0.00079*H*	2.0	−0.7	2.0

[1] The observatory standard for inclination in 1906 and 1908 was Dover dip-circle No. 147, needles 1, 2, and 3; the standard for 1915 to 1920 was earth inductor No. 109 by Toepfer and Son.

Hence, we obtain weighted mean values as follows:

(3) I. M. S.—Christchurch (Kew magnetomerer No. 1) = +0′.4 (1906–1920).
(3*a*) I. M. S.—Christchurch (Kew magnetometer No. 1) = +0.00073*H* (1906–1920).
(3*b*) I. M. S.—Christchurch (Dover dip circle No. 147, needles 1, 2, 3) = −1′.1 (1906–1908).
(3*c*) I. M. S.—Christchurch (Toepfer inductor No. 109) = −0′.1 (1915–1920).

[a] See *Res. Dep. Terr. Mag.*, Vol. II, pp. 229–231.

NO. 4.—DOMINION OBSERVATORY, OTTAWA, CANADA.

Comparisons of the instruments of the Dominion Observatory were secured at the Standardizing Magnetic Observatory of the Department of Terrestrial Magnetism at Washington, D. C., in November and December 1915, by Observers C. A. French, of the Dominion Observatory, and H. W. Fisk and W. F. Wallis of the Department. The instruments used were D. O. magnetometers Tesdorpf No. 1977 and Cooke No. 15, D. O. earth-inductor Toepfer No. 1911, D. O. dip circle Dover No. 145, C.I.W. standard magnetometer No. 3, and C. I. W. standard earth-inductor Schulze No. 48. The observations were made at the 2 tripod stations N_m and S_m, and at the 3 piers N_e, S_e, and E_m, of the Standardizing Magnetic Observatory; a full description of this Observatory and a plan showing the locations of the stations used is given in Volume II, *Researches, Department of Terrestrial Magnetism*, pages 199 to 200 and Fig. 9. The galvanometers used for the observations with the earth inductors were mounted on piers N_g, S_g, and E_s.

Declination observations with magnetometer Tesdorpf No. 1977 were made both with magnet 10 and with magnet 14; magnet 10 has been used at all field stations occupied with this instrument by the observers of the Dominion Observatory. Because of the range in the results of the declination-comparisons at Washington, Ottawa, and Agincourt, 1908–1915, special tests and observations (Tables 4D and 4E) were made at Washington in November 1915 to determine whether there was any magnetic impurity in the copper dampers, or in the brass of the magnet house, of this instrument. These tests showed that, for normal positions of dampers, there is no effect on account of possible magnetic impurity of the metal, even when the suspended magnet is used at highest-possible or lowest-possible positions in its housing. The variation of the declination-correction for magnetometer No. 1977 may have to be ascribed to slight displacements of the reflecting mirror mounted in the hollow magnet, or to the fact that the short suspension bars of the magnet may not invariably take the same positions in the suspension hook.

TABLE 4A.—*Results of Declination Comparisons at the Standardizing Magnetic Observatory of the Department of Terrestrial Magnetism at Washington, 1915.*

Date	Local mean time		Declination obtained[1]		I. M. S.—D. O. 1977 (magnet 10)	Remarks
	From	To	I. M. S.[2]	D. O. 1977 (magnet 10)		
1915	h m	h m	° ′	° ′	′	
Nov. 20	12 52	13 01	−4 38.7	−4 39.5	+0.8	C. I. W. No. 3 at N_m; D. O. No. 1977 at at S_m.
22	9 37	9 46	35.0	37.0	+2.0	
22	10 24	10 33	37.4	39.2	+1.8	
22	15 32	15 41	37.0	38.3	+1.3	
23	9 29	9 38	34.8	36.0	+1.2	
23	14 58	15 08	39.2	41.3	+2.1	
23	15 38	15 47	38.3	39.3	+1.0	
29	15 40	15 49	37.5	38.4	+0.9	C. I. W. No. 3 at S_m; D. O. No. 1977 at N_m.
30	11 56	12 05	36.7	38.8	+2.1	
30	13 44	13 53	36.4	38.3	+1.9	
30	16 05	16 14	36.8	38.5	+1.7	
Dec. 1	9 09	9 18	34.0	35.0	+1.0	
1	11 57	12 06	38.8	40.0	+1.2	
Mean value of [I. M. S.—D. O. 1977 (magnet 10)]..					+1.5	

[1] All values are referred to station N_m; $N_m = S_m + 0'.5$, as derived from this series. Observers: D. O. No. 1977, C. A. French of the Dominion Observatory; C. I. W. No. 3, H. W. Fisk of the Department of Terrestrial Magnetism.

[2] These are values obtained with C. I. W. No. 3 referred to I. M. S.; I. M. S.—C. I. W. No. 3 = −0′.1.

TABLE 4B.—*Results of Declination Comparisons at the Standardizing Magnetic Observatory of the Department of Terrestrial Magnetism at Washington, 1915.*

Date	Local mean time From	Local mean time To	Declination obtained[1] I. M. S.[2]	Declination obtained[1] D. O. 1977 (magnet 14)	I. M. S.—D. O. 1977 (magnet 14)	Remarks
1915	h m	h m	° ′	° ′	′	
Nov. 20	13 20	13 29	−4 38.5	−4 37.8	−0.7	C. I. W. No. 3 at N_m; D. O. No. 1977 at S_m.
22	9 20	9 29	34.5	34.3	−0.2	
22	10 41	10 50	37.5	37.0	−0.5	
22	14 50	15 00	36.9	36.1	−0.8	
23	9 44	9 53	35.5	34.5	−1.0	
23	14 44	14 53	39.8	40.2	+0.4	
23	15 52	16 01	37.4	36.4	−1.0	
29	15 52	16 01	37.2	36.2	−1.0	C. I. W. No. 3 at S_m; D. O. No. 1977 at N_m.
30	11 45	11 54	36.6	36.4	−0.2	
30	13 56	14 05	36.5	36.3	−0.2	
30	15 54	16 03	36.9	36.3	−0.6	
Dec. 1	9 21	9 30	34.0	33.7	−0.3	
1	11 46	11 55	38.4	37.9	−0.5	
Mean value of [I. M. S.—D. O. 1977 (magnet 14)]..					−0.5	

[1] All values are referred to station S_m; $S_m = N_m + 0'.5$, as derived from this series. Observers: D. O. No. 1977, C. A. French of the Dominion Observatory; C. I. W. No. 3, H. W. Fisk of the Department of Terrestrial Magnetism.

[2] These are values obtained with C. I. W. No. 3 referred to I. M. S.; I. M. S.—C. I. W. No. 3 = −0′.1.

TABLE 4C.—*Results of Declination Comparisons at the Standardizing Magnetic Observatory of the Department of Terrestrial Magnetism at Washington, 1915.*

Date	Local mean time From	Local mean time To	Declination obtained[1] I. M. S.[2]	Declination obtained[1] D. O. 15	I. M. S.—D. O. 15	Remarks
1915	h m	h m	° ′	° ′	′	
Nov. 20	12 52	13 01	−4 38.7	−4 39.2	+0.5	C. I. W. No. 3 at N_m; D. O. No. 15 at E_m.
20	13 20	13 29	38.5	38.4	−0.1	
22	9 20	9 29	34.5	34.6	+0.1	
22	9 37	9 46	35.0	35.1	+0.1	
22	10 24	10 33	37.4	37.6	+0.2	
22	10 41	10 50	37.5	37.7	+0.2	
22	14 50	15 00	36.9	36.6	−0.3	
22	15 32	15 41	37.0	36.8	−0.2	
23	9 29	9 38	34.8	34.3	−0.5	
23	9 44	9 53	35.5	34.6	−0.9	
23	14 44	14 53	39.8	39.2	−0.6	
23	14 58	15 08	39.2	38.0	−1.2	
23	15 38	15 47	38.3	37.5	−0.8	
23	15 52	16 01	37.4	36.8	−0.6	
24	9 46	9 56	35.8	36.1	+0.3	
24	10 01	10 10	36.6	36.7	+0.1	
24	10 33	10 42	38.3	37.9	−0.4	
24	10 46	10 55	38.9	38.5	−0.4	
24	10 59	11 08	39.4	39.3	−0.1	
24	11 12	11 21	40.0	39.6	−0.4	
24	12 53	13 02	41.4	41.2	−0.2	
24	13 03	13 12	41.2	41.0	−0.2	
24	13 17	13 26	40.4	40.4	0.0	
24	13 32	13 41	40.3	39.9	−0.4	
24	13 51	14 00	39.4	39.1	−0.3	
24	14 01	14 10	39.5	39.2	−0.3	
24	14 24	14 33	38.9	38.6	−0.3	
24	14 34	14 43	38.3	38.2	−0.1	
24	15 41	15 51	37.0	36.6	−0.4	
24	15 52	16 01	36.6	36.3	−0.3	
24	16 05	16 14	36.1	36.1	0.0	
24	16 15	16 22	36.1	36.1	0.0	
26	9 38	9 47	35.7	34.8	−0.9	
26	9 54	10 03	36.3	35.5	−0.8	
26	11 20	11 29	39.9	38.9	−1.0	
26	11 34	11 43	40.4	40.0	−0.4	

[1] See p. 416. [2] See p. 416.

TABLE 4C.—*Results of Declination Comparisons at the Standardizing Magnetic Observatory of the Department of Terrestrial Magnetism at Washington, 1915*—Concluded.

Date	Local mean time From	Local mean time To	Declination obtained[1] I. M. S.[2]	Declination obtained[1] D. O. 15	I. M. S.—D. O. 15	Remarks
1915	h m	h m	° ′	° ′	′	
Dec. 1	14 04	14 13	−4 38.0	−4 37.6	−0.4	C. I. W. No. 3 at E_m; D. O. No. 15 at N_m.
2	9 36	9 45	34.3	33.8	−0.5	
2	10 17	10 26	34.9	34.8	−0.1	
2	12 52	13 01	36.9	36.5	−0.4	
2	14 17	14 26	36.8	36.4	−0.4	
3	9 23	9 32	33.0	32.9	−0.1	
3	9 56	10 04	34.3[3]	33.3[3]	−1.0	
3	12 30	12 38	39.3	39.3	0.0	
Mean value of (I. M. S.—D. O. 15)..............					−0.3	

[1] All values are referred to station N_m; $N_m = E_m + 0'.7$, as derived from this series. Observers: D. O. No. 15, W. F. Wallis of the Department of Terrestrial Magnetism; C. I. W. No. 3, H. W. Fisk of the Department of Terrestrial Magnetism.

[2] These are values obtained with C. I. W. No. 3 referred to I. M. S.; I. M. S.—C. I. W. No. 3 = −0′.1.

[3] This value was obtained from 4 magnet-inverted and 2 magnet-erect readings only.

TABLE 4D.—*Results of Special-Test Declination Comparisons at the Standardizing Magnetic Observatory of the Department of Terrestrial Magnetism at Washington, 1915.*

Date	Local mean time From	Local mean time To	Declination obtained[1] I. M. S.[2]	Declination obtained[1] D. O. 1977 (magnet 10)	I. M. S.—D. O. 1977 (magnet 10)	Remarks
1915	h m	h m	° ′	° ′	′	
Nov. 24	10 01	10 10	−4 36.6	−4 38.2	+1.6	Magnet 10 of No. 1977 at highest possible position in magnet-house.[3]
24	10 33	10 42	38.3	39.8	+1.5	Magnet 10 at normal position.
24	11 12	11 21	40.0	40.6	+0.6	Magnet 10 at lowest possible position.
24	11 47	11 56	41.0	42.3	+1.3	As above.
24	12 53	13 02	41.4	43.7	+2.3	Magnet 10 at normal position, dampers of house unscrewed ¼ turn.
24	13 03	13 12	41.2	43.5	+2.3	As above.
24	13 17	13 26	40.4	41.3	+0.9	Magnet 10 at normal position, dampers of house unscrewed ½ turn.
24	13 32	13 41	40.3	41.3	+1.0	As above.
24	13 51	14 00	39.4	39.6	+0.2	Magnet 10 at normal position, dampers of house unscrewed ¾ turn.
24	14 01	14 10	39.5	39.4	−0.1	As above.
24	14 24	14 33	38.9	41.0	+2.1	Magnet 10 at normal position, dampers of house unscrewed 1 turn.
24	14 34	14 43	38.3	40.9	+2.6	As above.
24	15 41	15 51	37.0	38.8[4]	+1.8	Magnet 10 at normal position, dampers removed.
24	15 52	16 01	36.6	37.9	+1.3	As above.
26	9 38	9 47	35.7	37.0	+1.3	As above.
26	11 20	11 29	39.9	40.4	+0.5	As above.

[1] C. I. W. No. 3 was at station N_m and D. O. No. 1977 at station S_m throughout; all values are referred to station N_m; $N_m = S_m + 0'.5$, see Table 4A. Observers: D. O. No. 1977, C. A. French of the Dominion Observatory; C. I. W. No. 3, H. W. Fisk of the Department of Terrestrial Magnetism.

[2] These are values obtained with C. I. W. No. 3 referred to I. M. S.; I. M. S.—C. I. W. No. 3 = −0′.1.

[3] The vertical displacement between highest-possible and lowest-possible positions of magnet 10 in the magnet-house of D. O. No. 1977 is about 1 mm. only.

[4] Magnet 10 of D. O. No. 1977 was dropped on floor of Observatory between local mean times 15h 47m and 15h 49m.

TABLE 4E.—*Results of Special-Test Declination Comparisons at the Standardizing Magnetic Observatory of the Department of Terrestrial Magnetism at Washington, 1915.*

Date	Local mean time		Declination obtained[1]		I. M. S.—D. O. 1977 (magnet 14)	Remarks
	From	To	I. M. S.[2]	D. O. 1977 (magnet 14)		
1915	h m	h m	° ′	° ′	′	
Nov. 24	9 46	9 56	−4 35.8	−4 35.8	0.0	Magnet 14 of No. 1977 at highest possible position in magnet-house.[3]
24	10 46	10 55	38.9	38.8	−0.1	Magnet 14 at normal position.
24	10 59	11 08	39.4	39.2	−0.2	Magnet 14 at lowest-possible position.
24	16 05	16 14	36.1	36.1	0.0	Magnet 14 at normal position, dampers of house removed.
24	16 15	16 22	36.1	36.0	−0.1	As above.
26	9 54	10 03	36.3	35.6	−0.7	As above.
26	11 34	11 43	40.4	39.4	−1.0	As above.

[1] C. I. W. No. 3 was at station N_m and D. O. No. 1977 at station S_m throughout; all values are referred to station N_m; $N_m = S_m + 0'.5$, see Table 4B. Observers: D. O. No. 1977, C. A. French of the Dominion Observatory; C. I. W. No. 3, H. W. Fisk of the Department of Terrestrial Magnetism.

[2] These are values obtained with C. I. W. No. 3 referred to I. M. S.; I. M. S.—C. I. W. No. 3 = −0′.1.

[3] The vertical displacement between highest-possible and lowest-possible positions of magnet 14 in the magnet-house of D. O. No. 1977 is about 1 mm. only.

TABLE 4F.—*Results of Horizontal-Intensity Comparisons at the Standardizing Magnetic Observatory of the Department of Terrestrial Magnetism at Washington, 1915.*

Date	Local mean time		Hor. int. obtained[1]		I. M. S.—D. O. 1977	Remarks
	From	To	I. M. S.[2]	D. O. 1977[3]		
1915	h m	h m	γ	γ	γ	
Nov. 20	14 11	16 36	18984	19027	−43	C. I. W. No. 3 at N_m; D. O. No. 1977 at S_m.
22	11 25	14 36	954	003	−49	
23	10 20	12 39	959	011	−52	
30	9 38	11 34	982	030	−48	C. I. W. No. 3 at S_m; D. O. No. 1977 at N_m.
30	14 16	15 46	991	038	−47	
Dec. 1	9 55	11 36	979	028	−49	
Mean value of (I. M. S.—D. O. 1977)...........					−48.2γ or −0.00253H	

[1] All values are referred to station N_m; $N_m = S_m + 5.8\gamma$, as derived from this series. Observers: D. O. No. 1977, C. A. French of the Dominion Observatory; C. I. W. No. 3, H. W. Fisk of the Department of Terrestrial Magnetism.

[2] These are values obtained with C. I. W. No. 3, using constants of December 12, 1910, referred to I. M. S.; I. M. S.—C. I. W. No. 3 = 0.00000H.

[3] Using magnets 46 and 10, constants being those adopted for the year 1914 by the Dominion Observatory.

TABLE 4G.—*Results of Horizontal-Intensity Comparisons at the Standardizing Magnetic Observatory of the Department of Terrestrial Magnetism at Washington, 1915.*

Date	Local mean time		Hor. int. obtained[1]		I. M. S.—D. O. 15	Remarks
	From	To	I. M. S.[2]	D. O. 15[3]		
1915	h m	h m	γ	γ	γ	
Nov. 20	14 10	16 36	18984	18957	+27	C. I. W. No. 3 at N_m; D. O. No. 15 at E_m.
22	11 25	14 36	8954	936	+18	
23	11 20	12 38	8959	943	+16	
Dec. 1	14 19	16 38	8987	975	+12	C. I. W. No. 3 at E_m; D. O. No. 15 at N_m.
2	10 36	12 44	8984	962	+22	
2	14 31	16 42	9000	979	+21	
3	10 14	12 16	8966	942	+24	
Mean value of (I. M. S.—D. O. 15).............					+20.0γ or +0.00106H	

[1] All values are referred to station N_m; $N_m = E_m + 1.6\gamma$, as derived from this series. Observers: D. O. No. 15, W. F. Wallis of the Department of Terrestrial Magnetism; C. I. W. No. 3, H. W. Fisk of the Department of Terrestrial Magnetism.

[2] These are the values obtained with C. I. W. No. 3, using constants of December 12, 1910, referred to I. M. S.; I. M. S.—C. I. W. No. 3 = 0.00000H.

[3] Constants of December 29, 1915, were used in obtaining these values.

TABLE 4H.—*Results of Inclination Comparisons at the Standardizing Magnetic Observatory of the Department of Terrestrial Magnetism at Washington, 1915.*

Date	Local mean time		Inclination obtained[1]		I. M. S.—D. O. 1911	Remarks
	From	To	I. M. S.[2]	D. O. 1911		
1915	h m	h m	° ′	° ′	′	
Nov. 27	9 40	10 18	+71 01.8	+71 02.3	−0.5	
27	10 48	11 14	02.4	03.2	−0.8	
27	11 54	12 26	02.2	02.8	−0.6	
27	13 28	13 56	01.6	02.4	−0.8	
27	14 30	14 56	01.7	01.8	−0.1	C. I. W. No. 48 at N_e; D. O. No. 1911 at E_m.
27	15 11	15 34	01.9	02.0	−0.1	
27	15 55	16 18	01.9	01.9	0.0	
29	9 52	10 20	03.0	03.0	0.0	
29	10 36	11 04	03.2	03.1	+0.1	
29	11 37	12 00	03.0	03.0	0.0	
29	12 14	12 34	02.8	02.8	0.0	
Dec. 4	14 06	14 36	01.9	02.2	−0.3	
4	14 47	15 16	01.6	01.9	−0.3	
4	15 46	16 20	01.2	01.6	−0.4	C. I. W. No. 48 at E_m; D. O. No. 1911 at N_e.
6	9 26	10 05	03.4[3]	03.6[3]	−0.2	
6	10 41	11 07	04.6[3]	04.7[3]	−0.1	
6	13 44	14 15	06.6[3]	06.8[3]	−0.2	
Mean value of (I. M. S.—D. O. 1911)............					−0.25	

[1] All values are referred to station N_e; $N_e = E_m - 0'.2$, as derived from this series. Observers: D. O. 1911, work at E_m, W. F. Wallis of the Department of Terrestrial Magnetism, work at N_e, C. A. French of the Dominion Observatory; C. I. W. No. 48, H. W. Fisk of the Department of Terrestrial Magnetism.
[2] These are values obtained with C. I. W. No. 48; I. M. S.—C. I. W. No. 48 = 0′.0.
[3] A magnetic storm was in progress during these observations; extreme precautions were taken to make the observations with the two instruments strictly simultaneous.

TABLE 4I.—*Results of Inclination Comparisons at the Standardizing Magnetic Observatory of the Department of Terrestrial Magnetism at Washington, 1915.*

Date	Local mean time		Inclination obtained[1]		I. M. S.—D. O. 145	Remarks
	From	To	I. M. S.[2]	D. O. 145		
1915	h m	h m	° ′	° ′	′	
Nov. 27	9 40	10 16	+71 01.8	+71 00.8	+1.0	
27	10 48	11 12	02.4	01.9	+0.5	
27	11 54	12 25	02.2	01.7	+0.5	
27	13 26	13 56	01.6	01.2	+0.4	C. I. W. No. 48 at N_e; D. O. No. 145 at S_e.
27	14 30	14 56	01.7	01.6	+0.1	
27	15 10	15 34	01.9	01.5	+0.4	
27	15 53	16 16	01.9	01.2	+0.7	
Dec. 3	14 57	15 34	01.6	01.2	+0.4	
3	15 45	16 10	01.6	01.4	+0.2	
4	9 26	9 50	03.0	02.4	+0.6	C. I. W. No. 48 at S_e; D. O. No. 145 at N_e.
4	10 08	10 36	03.5	03.1	+0.4	
4	11 02	11 26	03.3	02.4	+0.9	
4	11 42	12 09	03.0	01.9	+1.1	
Mean value of (I. M. S.—D. O. 145).............					+0.6	

[1] All values are referred to station N_e; $N_e = S_e + 0'.0$, as derived from this series. Observers: D. O. No. 145, C. A. French of the Dominion Observatory; C. I. W. No. 48, H. W. Fisk of the Department of Terrestrial Magnetism.
[2] These are the values obtained with C. I. W. No. 48; I. M. S.—C. I. W. No. 48 = 0′.0.

Assembling the chief results, we obtain:

(4) I. M. S. − Dominion Observatory (Tesdorpf magnetometer No. 1977, magnet 10) = +1′.5 (1915).

(4*a*) I. M. S. − Dominion Observatory (Tesdorpf magnetometer No. 1977, magnet 14) = −0′.5 (1915).

(4*b*) I. M. S. − Dominion Observatory (Cooke magnetometer No. 15) = −0′.3 (1915).

(4*c*) I. M. S. − Dominion Observatory (Tesdorpf magnetometer No. 1977) = −0.00253H (1915).

(4*d*) I. M. S. — Dominion Observatory (Cooke magnetometer No. 15) = $+0.00106H$ (1915).
(4*e*) I. M. S. — Dominion Observatory (Earth inductor No. 1911, by Toepfer) = $-0'.25$ (1915).
(4*f*) I. M. S. — Dominion Observatory (Dover dip circle No. 145, needles 1 and 2) = $+0'.6$ (1915).
(4*g*) I. M. S. — Dominion Observatory (C.I.W. universal magnetometer No. 20)[a] = $-0'.7$ (1915–1921).
(4*h*) I. M. S. — Dominion Observatory (C.I.W. universal magnetometer No. 20)[a] = $-0.00023H-(t-1915.19)\ 0.00010H$ (Mar. 1915–June 1921, constants of March 25, 1916).
(4*i*) I. M. S. — Dominion Observatory (C.I.W. universal magnetometer No. 20)[a] = $-0.00010H$ (July 1921, constants of July 31, 1921).
(4*j*) I. M. S. — Dominion Observatory (C.I.W. universal magnetometer No. 20)[a] = $-0'.1$ (1915–1921).

PREVIOUS COMPARISONS OF THE DOMINION-OBSERVATORY INSTRUMENTS.

Simultaneous comparisons in declination and in horizontal intensity were made on April 7 and 9, 1908, between magnetometers D.O. No. 1977 and C.I.W. No. 3, at stations A_m and C_m, Washington, D. C. (see page 172 of Volume I, *Researches, Department of Terrestrial Magnetism*, for descriptions of stations); the station-differences having been determined from other observations at the time, the stations were not exchanged. From 11 sets of declination comparisons, the mean value of [I.M.S.—1977 (magnet 10)] was found equal to $+5'.2$. From 5 sets of horizontal-intensity comparisons, it was found that the mean value of [I.M.S.—1977 (magnets 46 and 10)] = $-0.00258H$. This value agrees well with that determined at Washington in 1915; too great weight, however, can not be given the 1908 result, since the reductions for magnetometer No. 1977 had to be based on the mean value of distribution coefficient derived from only the 5 sets of comparison-observations.

Dr. O. Klotz, director of the Dominion Observatory, courteously supplied the results of declination-comparisons at Ottawa, 1912–1915, between D.O. magnetometers Tesdorpf No. 1977 and Cooke No. 15, as also the results of inclination-comparisons at Ottawa, 1912–1915, between D.O. earth inductor Toepfer No. 1911 and D.O. dip circle Dover No. 145 (needles 1 and 2). The observations for these comparisons were made alternately on the north and south piers in the absolute magnetic observatory, without exchange of stations, except in 1914, when an exchange was made for the declination-comparisons, and the station-difference was found to be $0'.0$. Table 4J summarizes the results of these comparisons.

Dr. Klotz likewise supplied the results of comparison-observations, made in the Absolute Observatory at Agincourt from 1908–1915, between the instruments of the Dominion Observatory and those of the Agincourt Observatory. All observations with D.O. magnetometer, Tesdorpf No. 1977 (magnet 10 for declination, except as noted, and magnets 46 and 10 for horizontal intensity), were made on pier *B*, and the Agincourt-values were derived from eye-readings of the variometers. All observations with D.O. dip circle, Dover No. 145 (needles 1 and 2), were made on pier *E*, and all observations with the Agincourt dip circle, Dover No. 200 (needles 1 and 2), were made on pier *D*. As stations were not exchanged, it was necessary to assume, in deriving the results of Tables 4K, 4L, and 4M, that the station-differences were negligible. The constants of magnetometer No. 1977 were those adopted for each year by the Dominion Observatory using the mean value of P' (Q assumed zero) for the year, except that for 1908 the value of P' derived from a set of observations was used to reduce that set; for 1915 the adopted constants for 1914 were used.

[a] See pp. 401–402.

TABLE 4J.—*Results of Comparisons by the Dominion Observatory at Ottawa, 1912–1915.*

No.	Date	Declination			Inclination		
		No. of sets	D. O. 15—1977 (magnet 10)	I. M. S.—D. O. 1977 (magnet 10)[1]	No. of sets	1911—145 (1 and 2)	I. M. S.—D. O. 145 (1 and 2)[2]
			′	′		′	′
1	1912, April..........	6	+0.4	+0.1	4	+0.26	
2	1912, October........	7	+2.4	+2.1	..	......	0.0
3	1912, November......	..	......	......	..	+0.17	
4	1913, April..........	..	......	......	10	−0.26	−0.5
5	1913, Oct. and Nov..	..	......	......	8	−0.24	
6	1914, April..........	..	......	......	10	−0.12	−0.2
7	1914, November......	18	+2.9	+2.6	10	+0.14	
8	1915, April..........	8	+3.8	+3.5	10	+0.60	+0.4
9	1915, November......	12	+2.8	+2.5	8	+0.76	

[1] Assuming (I. M. S.—D. O. 15) = −0′.3, as found in 1915.
[2] Assuming (I. M. S.—D. O. 1911) = 0′.25, as found in 1915, and that station-difference is negligible.

TABLE 4K.—*Summary of Results of Declination Comparisons of Dominion-Observatory Magnetometer, Tesdorpf No. 1977, with Standard (I. M. S.), 1908–1915.*

a. Results for Magnet 10 of Magnetometer No. 1977.

No.	Date	No. of sets	Ag. (T. D.)—1977 (10)	I. M. S.—1977 (10)	Place of comparisons	Observer[1]	Remarks
			′	′			
1	1908, April..........	11	......	+5.2	Washington.....	C. I. W.........	Direct result.
2	1908, July...........	2	+3.3	+2.2	Agincourt[2]......		
3	1909, May...........	2	+1.9	+0.8	"		
4	1909, October........	2	+1.7	+0.6	"		
5	1910, May...........	2	+4.3	+3.2	"		
6	1910, October........	2	+3.0	+1.9	"		
7	1911, May...........	3	+1.2	+0.1	"		
8	1911, October........	2	+1.4	+0.3	"		
9	1912, April..........	6	+0.8	−0.3	"		
10	1912, April..........	6	......	+0.1	Ottawa[3]........		
11	1912, October........	7	......	+2.1	"	D. O...........	Indirect results.
12	1913, March.........	8	+1.1	0.0	Agincourt[2]......		
13	1913, October........	6	+0.6	−0.5	"		
14	1914, April..........	5	+1.4	+0.3	"		
15	1914, Oct., Nov......	5	+2.9	+1.8	"		
16	1914, November......	18	......	+2.6	Ottawa[3]........		
17	1915, April..........	8	......	+3.5	"		
18	1915, May...........	3	+3.9	+2.8	Agincourt[2]......		
19	1915, October........	6	+3.4	+2.3	"		
20	1915, November......	12	......	+2.5	Ottawa[3]........		
21	1915, Nov., Dec......	13	......	+1.5	Washington.....	D. O. and C. I. W.	Direct result.

b. Results for Magnet 14 of Magnetometer No. 1977.

No.	Date	No. of sets	Ag. (T. D.)—1977 (14)	I. M. S.—1977 (14)	Place of comparisons	Observer[1]	Remarks
			′	′			
22	1915, October........	3	+1.6	+0.5	Agincourt[2]......	D. O...........	Indirect result.
23	1915, November......	13	.....	−0.5	Washington	D. O. and C.I.W.	Direct result.

[1] C. I. W. stands for observer of the Carnegie Institution of Washington, and D. O. for the Observer of the Dominion Observatory.

[2] To obtain the results from the comparisons at Agincourt, it was necessary to apply the quantity [I. M. S.—Agincourt (Toronto declinometer)] = −1′.1; see Vol. II, *Res. Dep. Terr. Mag.*, p. 216. equation 1. By means of the corresponding comparisons at Ottawa (see foot-note 3) and those at Agincourt for the same years, this quantity, thus indirectly derived, was −1′.2.

[3] The comparisons at Ottawa were made between the Dominion-Observatory instruments, Cooke magnetometer No. 15 and Tesdorpf magnetometer No. 1977 (magnet 10). It was necessary to assume that the quantity (I. M. S.—D. O. Cooke No. 15) = −0′.3, as found at Washington in 1915, applied throughout the interval 1912-1915.

TABLE 4L.—*Summary of Results of Horizontal-Intensity Comparisons of Dominion-Observatory Magnetometer, Tesdorpf No. 1977 (Magnets 46 and 10), with Standard (I. M. S.), 1908–1915.*

No.	Date	No. of sets or weight	Ag. (Ell. 98)[1] —1977	I. M. S. —1977	Place of comparisons	Observer	Remarks
1	1908, April	5	....	$-0.00258H$	Washington	C. I. W.	Direct result.
2	1908, July	1	$-0.00197H$	$-0.00189H$	Agincourt[2]	D. O.	Indirect results.
3	1909, May	1	$-0.00263H$	$-0.00255H$	"	D. O.	Indirect results.
4	1909, October	1	$-0.00177H$	$-0.00169H$	"	D. O.	Indirect results.
5	1910, May	1	$-0.00290H$	$-0.00282H$	"	D. O.	Indirect results.
6	1910, October	2	$-0.00208H$	$-0.00200H$	"	D. O.	Indirect results.
7	1911, May	1	$-0.00263H$	$-0.00255H$	"	D. O.	Indirect results.
8	1911, October	1	$-0.00256H$	$-0.00248H$	"	D. O.	Indirect results.
9	1912, April	2	$-0.00234H$	$-0.00226H$	"	D. O.	Indirect results.
10	1913, March	2	$-0.00240H$	$-0.00232H$	"	D. O.	Indirect results.
11	1913, October	2	$-0.00246H$	$-0.00238H$	"	D. O.	Indirect results.
12	1914, April	2	$-0.00217H$	$-0.00209H$	"	D. O.	Indirect results.
13	1914, Oct., Nov.	2	$-0.00264H$	$-0.00256H$	"	D. O.	Indirect results.
14	1915, May	2	$-0.00268H$	$-0.00260H$	"	D. O.	Indirect results.
15	1915, October	3	$-0.00248H$	$-0.00240H$	"	D. O.	Indirect results.
16	1915, Nov., Dec.	6	....	$-0.00253H$	Washington	D. O. and C. I. W.	Direct result.
	Weighted mean value of [I. M. S.—1977 (magnets 46 and 10)]			$-0.00240H$			

(It is believed that preference should be given to the latest and directly-derived result at Washington: No. 16.)

[1] Referred to new constants; see Vol. II, *Res. Dep. Terr. Mag.*, p. 216, first paragraph.

[2] In obtaining the results from the comparisons at Agincourt, it was necessary to apply the quantity [I. M. S.—Agincourt (Elliott magnetometer No. 98 corrected)] = $+0.00008H$; see Vol. II, *Res. Dep. Terr. Mag.*, p. 216, equation (1*a*).

TABLE 4M.—*Summary of Results of Inclination Comparisons of Dominion-Observatory Dip Circle, Dover No. 145 (Needles 1 and 2), with Standard (I. M. S.), 1912–1915.*

a. Results of Comparisons at Agincourt.

No.	Date	Weight	Ag. (200)— D. O. (145)	I. M. S.— D. O. (145)	Place of comparisons	Observer	Remarks
			′	′			
1	1910, May	1	+0.2	+0.2	Agincourt[1]	Dominion Observatory	Indirect results.
2	1910, October	1	−1.2	−1.2	"	Dominion Observatory	Indirect results.
3	1911, May	1	−0.4	−0.4	"	Dominion Observatory	Indirect results.
4	1911, October	1	−0.5	−0.5	"	Dominion Observatory	Indirect results.
5	1912, April	2	−0.9	−0.9	"	Dominion Observatory	Indirect results.
7	1912, November	1	−0.6	−0.6	"	Dominion Observatory	Indirect results.
8	1913, March	2	−0.4	−0.4	"	Dominion Observatory	Indirect results.

b. Results of Comparisons at Ottawa and Washington.

No.	Date	No. of sets	D. O. (1911) —D. O. (145)	I. M. S.— D. O. (145)	Place of comparisons	Observer	Remarks
			′	′			
6	1912, April	4	+0.26	0.0	Ottawa[2]	Dominion Observatory	Indirect results.
7	1912, November	5	+0.17	−0.1	"	Dominion Observatory	Indirect results.
9	1913, April	10	−0.26	−0.5	"	Dominion Observatory	Indirect results.
10	1913, Oct., Nov.	8	−0.24	−0.5	"	Dominion Observatory	Indirect results.
11	1914, April	10	−0.12	−0.4	"	Dominion Observatory	Indirect results.
12	1914, November	10	+0.14	−0.1	"	Dominion Observatory	Indirect results.
13	1915, April	10	+0.60	+0.4	"	Dominion Observatory	Indirect results.
14	1915, November	8	+0.76	+0.5	"	Dominion Observatory	Indirect results.
15	1915, Nov., Dec.	13	....	+0.6	Washington	D. O. and C. I. W.	Direct result.

[1] The results from the Agincourt comparisons were obtained by applying the following quantities; (Agincourt inductor No. 89—Agincourt dip circle No. 200) = +0′.1, as found in 1911 (Vol. II, *Res. Dep. Terr. Mag.*, p. 216, equation IX); (I. M. S.—Agincourt inductor No. 89) = −0′.15, as found at Washington in 1915; hence, assuming no changes in instruments (I. M. S.—Agincourt dip circle No. 200) = 0′.0.

[2] In deriving the results from the Ottawa comparisons, it was necessary to assume that the quantity (I. M. S.—D. O. inductor No. 1911 = −0′.25, as found at Washington in 1915, applied throughout the period 1912 to 1915.

NO. 5.—ESKDALEMUIR OBSERVATORY, SCOTLAND.

The comparisons of 1915 were obtained by Superintendent L. F. Richardson and Mr. P. N. Skelton of the Observatory staff and Observer E. Kidson of the Carnegie Institution of Washington. The observations were made in the west and east absolute houses, each of which contains 3 piers lying in a magnetic east-west line. The piers in the 2 houses are numbered 1 to 6, beginning with the west pier in the west house as No. 1. The observations for magnetic declination and for magnetic horizontal intensity were made on piers 2 and 5, and those for magnetic inclination were made on piers 3 and 6. The Observatory azimuth mark, a vertical white band on a stone pillar one-half mile distant, was used; the true bearings of this mark from piers 2 and 5, supplied by Superintendent Richardson, were 4° 36′.2 and 8° 12′.5 west of south, respectively.

The Observatory instruments used were magnetometer No. 60 by Elliott and earth inductor No. 103 by Schulze. The values for intensity with magnetometer No. 60 depend upon the values of the distribution coefficients finally adopted by the Observatory authorities. The C.I.W. instrument used was magnetometer-inductor No. 26. The corrections on International Magnetic Standards,[a] applied to results obtained with magnetometer-inductor No. 26, were those finally adopted.

TABLE 5A.—*Results of Declination Comparisons at the Eskdalemuir Observatory, 1915.*

Date	Local mean time		Declination obtained[1]		I. M. S.—Eskdalemuir	Remarks
	From	To	I. M. S.	Eskdalemuir		
1915	h m	h m	° ′	° ′	′	
Sept. 20	10 08	10 17	−17 35.1	−17 34.2	−0.9	C. I. W. magnetometer No. 26 at *pier 2;* Eskdalemuir magnetometer No. 60 at *pier 5.*
20	10 26	10 35	35.6	34.6	−1.0	
20	10 45	10 54	36.1	35.6	−0.5	
20	11 01	11 10	37.2	36.3	−0.9	
20	11 20	11 29	37.6	36.8	−0.8	
20	11 35	11 44	38.2	37.2	−1.0	
21	14 21	14 41	40.7	39.7	−1.0	C. I. W. magnetometer No 26 at *pier 5;* Eskdalemuir magnetometer No. 60 at *pier 2.*
21	15 03	15 23	39.7	39.3	−0.4	
21	15 45	15 56	38.1	36.8	−1.3	
22	10 12	10 21	36.5	35.9	−0.6	
22	10 36	10 45	37.1	36.6	−0.5	
22	10 52	10 01	36.9	36.1	−0.8	
Mean value of (I. M. S.—Eskdalemuir 60).........					−0.8	

[1] All values are referred to *pier 5; pier 5 = pier 2* − 0′.8.

TABLE 5B.—*Results of Horizontal-Intensity Comparisons at the Eskdalemuir Observatory, 1915.*

Date	Local mean time[1]		Hor. int. obtained[2]		I. M. S.—Eskdalemuir	Remarks
	From	To	I. M. S.	Eskdalemuir		
1915	h m	h m	γ	γ	γ	
Sept. 17	14 20	15 39	16752	16773	−21	C. I. W. magnetometer No. 26 at *pier 2;* Eskdalemuir magnetometer No. 60 at *pier 5.*
18	9 41	10 59	40	54	−14	
18	11 08	12 24	38	52	−14	
22	11 23	12 41	54	66	−12	C. I. W. magnetometer No. 26 at *pier 5;* Eskdalemuir magnetometer No. 60 at *pier 2.*
25	9 40	11 03	30	47	−17	
25	14 01	15 19	55	75	−20	
Mean value of (I. M. S.—Eskdalemuir 60).........					−16.3γ or −0.00097H	

[1] The times given apply for the C. I. W. observations; the Eskdalemuir observations were not strictly simultaneous but where necessary have been reduced to times of the corresponding C. I. W. observations by differences determined from the magnetograms.

[2] All values are referred to *pier 5; pier 5 = pier 2* − 3γ.

[a] See *Res. Dep. Terr. Mag.*, Vol. II, pp. 270–278.

TABLE 5C.—*Results of Inclination Comparisons at the Eskdalemuir Observatory, 1915.*

Date	Local mean time[1]		Inclination obtained[2]		I. M. S.—Eskdalemuir	Remarks
	From	To	I. M. S.	Eskdalemuir		
1915	h m	h m	° ′	° ′	′	
Sept. 20	14 46	15 34	+69 36.7	+69 36.8	−0.1	C. I. W. magnetometer No. 26 at *pier 3;* Eskdalemuir earth inductor No. 103 at *pier 6.*
21	10 17	10 44	38.5	38.5	0.0	
21	10 44	11 07	38.1	38.2	−0.1	
24	10 09	10 34	38.6	38.6	0.0	C. I. W. magnetometer No. 26 at *pier 6;* Eskdalemuir earth inductor No. 103 at *pier 3.*
24	10 46	11 14	38.5	38.7	−0.2	
24	11 27	11 54	39.3	39.5	−0.2	
Mean value of (I. M. S.—Eskdalemuir 103)......					−0.1	

[1] The times given apply for the C. I. W. observations; the Eskdalemuir observations were not strictly simultaneous but the intervals between the mean times for corresponding sets are not large enough to affect materially, because of the diurnal variation in inclination, the values for (I. M. S.—Eskdalemuir).
[2] All values are referred to *pier 6; pier 6=pier 3*—0′.0.

Assembling the results, we have:

(5) I. M. S.—Eskdalemuir (Elliott magnetometer No. 60) = −0′.8 (1915).
(5*a*) I. M. S.—Eskdalemuir (Elliott magnetometer No. 60) = −0.00097*H* (1915).
(5*b*) I. M. S.—Eskdalemuir (Schulze inductor No. 103) = −0′.1 (1915).

NO. 6.—GREENWICH OBSERVATORY, ENGLAND.

SERIES I, 1915.

The comparisons of 1915 were obtained by Messrs. H. S. Jones and W. W. Bryant of the Observatory staff and Observer E. Kidson of the Carnegie Institution of Washington. The observations were made at 3 stations in the absolute house, viz, the declinometer station, the intensity pier, and the inductor pier, and at a tent station which was 74 feet true south 31° 29′ east of the southeast corner of the absolute house. Since the Observatory instruments were used at only their usual places in the absolute house, and there was no exchange of stations, it was not possible to determine any station-differences which may exist. Observations with C.I.W. instrument could be made at only the declinometer station and at the intensity pier in the absolute house. The adopted results for the comparisons in declination and horizontal intensity, therefore, are based only upon the observations made with the C.I.W. instrument at the declinometer station and at the intensity pier and the corresponding data deduced from the Observatory magnetograms. The adopted results for the inclination comparisons depend only upon the observations with the Greenwich earth-inductor on its pier and with the C.I.W. magnetometer-inductor on the intensity pier The latter pier is 4 feet distant from the inductor pier; that the station-difference in inclination between the 2 piers is probably negligible is indicated by the comparisons made betweeen the Greenwich inductor on its pier and the C.I.W. instrument at the tent station (see Table 6C). For the work at the declinometer station a mark mounted on a fence-post about 200 yards distant was used; its true bearing, supplied by the Observatory authorities, was 354° 41′.8 west of south.

Subsequent to the work in April and prior to the comparisons in October, Mr. Bryant made some preliminary observations to test for magnetic impurity the slate cap of the intensity pier by making oscillation experiments at different points on the cap. These did not indicate any great disturbance. An observation on the dip-circle pier indicated some disturbance or difference between the two piers, but the observations were not conclusive. It appears probable, however, that, while the effect from the slate cap itself is very small, some disturbance exists in the region. As no changes in

the Observatory methods or arrangements were likely to be made in the near future, it was decided, after consultation with the Astronomer Royal, to compare directly the intensity results obtained with the C.I.W. magnetometer on the center of the intensity pier with those obtained from the Observatory magnetograms.

The Observatory absolute-instruments, viz, declinometer for declination, earth inductor for inclination, and Gibson magnetometer No. 3 for horizontal intensity, were used, and the data deduced from the Greenwich magnetograms depend upon base-line determinations made with them. The C.I.W. instrument used was magnetometer-inductor 26. The corrections on International Magnetic Standards[a] applied to results obtained with magnetometer-inductor 26 were those finally adopted.

TABLE 6A.—*Results of Declination Comparisons at the Greenwich Observatory, 1915.*[1]

Date	Local mean time		Declination obtained[2]		I. M. S.—Greenwich	Remarks
	From	To	I. M. S.	Greenwich		
1915	h m	h m	° ′	° ′	′	
Aug. 24	11 08	11 15	−14 59.0	−14 57.2	−1.8	C. I. W. magnetometer No. 26 at *declinometer station* throughout; the Greenwich values are from the magnetograms.
24	11 22	11 29	59.7	58.1	−1.6	
24	11 39	11 46	60.1	58.5	−1.6	
24	11 51	11 58	60.5	59.1	−1.4	
24	12 07	12 14	60.8	59.4	−1.3	
27	11 05	11 12	59.8	58.1	−1.7	
27	11 24	11 31	60.5	58.9	−1.6	
27	11 37	11 44	60.8	58.8	−2.0	
27	11 53	12 00	61.9	60.2	−1.7	
27	12 15	12 22	63.2	61.5	−1.7	
Mean value of (I. M. S.—Greenwich)............					−1.6	(weight, 1.0)

[1] Fourteen additional comparisons were obtained: 8 on August 14, 16, and 17, 1915, with C. I. W. magnetometer No. 26 at the tent station and 6 on August 23, 1915, with C. I. W. magnetometer No. 26 on the intensity pier, all with Greenwich declinometer at its station, but since there are no available data to determine station-differences, if any, these sets have been omitted. The resulting mean values of (I. M. S. at the tent station—Greenwich at the declinometer station) and of (I. M. S. at the intensity pier—Greenwich at the declinometer station) were −0′.9 and −3′.1, respectively. The latter is based upon a not especially trustworthy value for azimuth of mark.

[2] All values refer to the Greenwhich declinometer station.

TABLE 6B.—*Results of Horizontal-Intensity Comparisons at the Greenwich Observatory, 1915.*[1]

Date	Local mean time		Hor. int. obtained[2]		I. M. S.—Greenwich	Remarks
	From	To	I. M. S.	Greenwich		
1915	h m	h m	γ	γ	γ	
Aug. 18	10 10	11 35	18478	18498	−20	C. I. W. magnetometer No. 26 at *intensity pier* throughout; the Greenwich values are from the magnetograms.
18	11 43	15 23	496	506	−10	
18	15 29	16 47	508	522	−14	
Oct. 4	15 12	16 42	500	505	− 5	
5	9 37	10 56	484	495	−11	
5	12 39	13 15	492	496	− 4	
6	9 43	10 28				
Mean value of (I. M. S.—Greenwich)............					−10.7γ or −0.00058*H*	

[1] Four additional comparisons were obtained on August 14, 16, and 17, 1915, with C. I. W. magnetometer No. 26 at the tent station and with the Greenwich magnetometer Gibson No. 3 at the intensity pier; since there are no data available to determine station-difference, if any, these sets have been omitted. The resulting mean value of (I. M. S. at the tent station—Greenwich at the intensity pier) was −0.5γ.

[2] All values refer to the Greenwich intensity pier.

[a] See *Res. Dep. Terr. Mag.*, Vol. II, pp. 270–278.

TABLE 6C.—*Results of Inclination Comparisons at the Greenwich Observatory, 1915.*[1]

Date	Local mean time		Inclination obtained		I. M. S.—Greenwich	Remarks
	From	To	I. M. S.	Greenwich		
1915	h m	h m	° ′	° ′	′	
Aug. 21	11 31	11 41	+66 50.0	+66 50.6	−0.6	C. I. W. magnetometer No. 26 at the *intensity pier* and Greenwich inductor at the *inductor pier* throughout.[2]
21	11 43	11 54	50.0	50.6	−0.6	
21	12 05	12 16	49.1	49.9	−0.8	
21	12 19	12 28	48.7	49.3	−0.6	
21	12 39	12 49	48.5	49.3	−0.8	
21	12 51	13 03	48.5	49.2	−0.7	
Mean value of (I. M. S.—Greenwich inductor)....					−0.7	

[1] Twelve additional comparisons were obtained on August 19 and 20, 1915, with C. I. W. magnetometer No. 26 set up at the tent station with the Greenwich earth inductor on its pier; since there are no available data to determine station-difference, if any, these sets have been omitted. The resulting mean value of (I. M. S. at the tent station—Greenwich at the inductor pier) was −1′.0.

[2] It is assumed that the station-difference between the intensity and inductor piers is negligible since they are only 4 feet apart and the comparisons made with No. 26 at the tent station and the Greenwich inductor at the inductor pier, 80 feet from the tent station, indicate an approximate station-difference between tent station and inductor pier of less than 0′.5.

SERIES II, 1919.

Advantage was taken of the opportunity before Observer F. Brown's departure for field work in Cameroun and in Angola, Africa, to obtain during April 5 to 7, 1919, a second series of comparisons at Greenwich. Because of the very short time at Mr. Brown's disposal and because of other demands upon the time of the Observatory personnel a complete set of intercomparisons with interchange of stations was not feasible. The stations were as in 1915 except that in place of the tent station of 1915 a new tent station, designated *Tent 1919*, was occupied. This station was in the inclosure around the absolute house 20 paces south-southeast of the southeast corner of the latter; the north end of the northernmost and lowest building between the 28-inch dome and the tower of the Observatory was used as an azimuth mark, its true bearing, as determined by Mr. Brown, being 92° 25′.1 west of south. Declination and inclination observations were made at the tent station by Mr Brown; simultaneous inclination observations only were obtained by Mr. W. W. Bryant, Superintendent of the Magnetic Department, on the inductor pier at the south end of the absolute house. The C. I. W. horizontal-intensity observations were made on the center of the intensity pier as in 1915. It is assumed that any station-differences are negligible as the locality of the absolute house had been tested by the Observatory authorities and found free of local disturbance.

The absolute instruments of the Observatory were as for the 1915 series, and the Observatory data given for declination and for horizontal intensity were deduced from the magnetograms standardized by them. The C. I. W. instruments were magnetometer No. 13 and dip circle No. 177 with needles 13X and 16X. The behavior of the dip circle was not altogether satisfactory, values by different needles being erratic; the results given in Table 6E must, therefore, be regarded only as a general confirmation of those obtained in 1915. The corrections on International Magnetic Standards applied to the C. I. W. results are those tentatively adopted pending return and restandardization at Washington, probably some time in 1922.

TABLE 6D.—*Results of Declination Comparisons at the Greenwich Observatory, 1919.*

Date	Local mean time		Declination obtained[1]		I. M. S.—Greenwich	Remarks
	From	To	I. M. S.	Greenwich		
1919	h m	h m	° ′	° ′	′	
Apr. 6	15 21	15 28	−14 28.6	−14 27.5	−1.1	C. I. W. magnetometer No. 13 at station *Tent 1919;* the Greenwich values are from the magnetograms.
6	15 35	15 42	28.3	27.4	−0.9	
6	15 52	16 01	28.8	27.5	−1.3	
6	16 08	16 15	27.6	26.4	−1.2	
6	16 23	16 32	27.0	26.1	−0.9	
7	9 20	9 27	20.1	19.9	−0.2	
7	9 34	9 41	22.0	20.4	−1.6	
Mean value of (I. M. S.—Greenwich)............					−1.0	(weight, 1.0)

[1] Station-difference between *Tent 1919* and the Greenwich declinometer station, upon observations at which the magnetogram base-line value depends, is assumed to be negligible.

TABLE 6E.—*Results of Horizontal-Intensity Comparisons at the Greenwich Observatory, 1919.*

Date	Local mean time		Hor. int. obtained[1]		I. M. S.—Greenwich	Remarks
	From	To	I. M. S.	Greenwich		
1919	h m	h m	γ	γ	γ	
Apr. 5	14 07	14 50	18444	18466	−22	C. I. W. magnetometer No. 13 at the *intensity pier* throughout.
5	15 44	16 23				
6	9 52	11 20	417	442	−25	
6	11 35	12 20	433	452	−19	
6	14 14	14 55				
Mean value of (I. M. S.—Greenwich)............					−22.0γ or −0.00119*H*	

[1] The Greenwich values are from the magnetograms, the base-line for which is determined from observations with the Greenwich magnetometer Gibson No. 3 at the intensity pier.

TABLE 6F.—*Results of Inclination Comparisons at the Greenwich Observatory, 1919.*

Date	Local mean time		Inclination obtained[1]		I. M. S.—Greenwich	Remarks
	From	To	I. M. S.	Greenwich		
1919	h m	h m	° ′	° ′	′	
Apr. 5	10 52	11 23	+66 52.6	+66 55.2	−2.6	C. I. W. dip circle No. 177 at station *Tent 1919;* Greenwich inductor at *inductor pier.*
5	11 46	12 16	53.5	54.4	−0.9	
7	8 18	8 48	51.7	53.9	−2.2	
Mean value of (I. M. S.—Greenwich)............					−1.9	

[1] It is assumed that any station-difference between the station *Tent 1919* and the inductor pier is negligible.

SUMMARY.

Assembling the chief results and using only inductor-comparisons for inclination, we obtain mean values as follows:

(6) I. M. S. − Greenwich (Declinometer) = −1′.3 (1915–1919).
(6*a*) I. M. S. − Greenwich (Gibson magnetometer No. 3) = −0.00058*H* (1915).
(6*b*) I. M. S. − Greenwich (Gibson magnetometer No. 3) = −0.00119*H* (1919).
(6*c*) I. M. S. − Greenwich (Earth inductor) = −0′.7 (1915).

NO. 7.—HELWAN OBSERVATORY, NEAR CAIRO, EGYPT.

The comparisons during July 12 to 26, 1918, at the Helwan Observatory were secured at the conclusion of Observer H. E. Sawyer's magnetic expedition through Africa. The stations used for the comparisons of 1911 and 1914[1] were reoccupied; these stations were the stone pier in small wooden hut, designated *Hut*, the north pier in porch or "Absolute Room," designated *N* (for *D* and *H* observations), and the south pier in porch, designated *S* (for *I* observations). The Observatory azimuth marks were used, the azimuths as supplied by Mr. Knox-Shaw, Director, being from *Hut*, 336° 55′.9 (in former years value used was 336° 55′.1) west of true south for point midway between two black dots on side of "Upper Office," and from *N*, 176° 24′.0 west of true south for monument. With reference to the value of azimuth for the station *Hut*, Mr. Knox-Shaw states that "A revised value of the azimuth of the mark used in the hut has been used. To compare station-difference (*N*—*Hut*) with values found in former years, a correction of −0′.8 must be applied to former years, i.e., in 1914 (*N* —*Hut*) would become +0′.6."

The Observatory instruments used in these comparisons were Kew-pattern magnetometer Elliott No. 87 (magnets 87*A* and 88*C*), and Dover dip circle No. 193 with needles 10 and 11. It is to be noted that these are the same instruments as those used by the Observatory for previous comparisons[a] except that needles 10 and 11 were used with dip circle 193 instead of needles 1 and 2 as in 1911 and needles 3 and 8 as in 1914. The C. I. W. instruments were magnetometer No. 17 (magnets 17*L* and 17*S*), and dip circle No. 223 with needles 1 and 3 of circle 223 and 5 and 6 of circle 178. Throughout, the method of comparison by simultaneous observations was employed, the observers exchanging stations in order to eliminate the station-differences. For the Observatory, all the declination and horizontal-intensity observations and the inclination observations of July 14 were made by Mr. H. Knox-Shaw, and the inclination observations of July 15 and 24 by Mr. P. A. Curry; the C. I. W. observations were all made by Mr. H. E. Sawyer.

The I. M. S. values given depend upon the constants finally adopted for C. I. W. magnetometer No. 17 and dip circle No. 223. When these instruments were returned from the field in January 1919, after continuous field service since November 1915, it was found that there had been an appreciable decrease in the moment of inertia for magnet 17*L* and its suspension. Examination of the comparisons with standards for magnetometer No. 17 showed that the decrease had taken place practically as a linear function of the time during which the instrument was in field service. For inclination, the corrections on I. M. S. finally adopted after careful analysis of the entire series of field results obtained during Mr. Sawyer's campaign are for I = +41°.1: needle 1 of circle 223, −0′.6; needle 3 of circle 223, +0′.2; needle 5 of circle 178, −2′.5; needle 6 of circle 178, 0′.0. Because of erratic behavior of needle 5 of circle 178, values determined by it have been weighted one-half in the table of results.

The Observatory results are as supplied by Mr. H. Knox-Shaw, Director of the Meteorological Service. The inclination values by circle 193 and needles 10 and 11 are "reduced to Helwan standard," i. e., to the standard of needles 3 and 8 which is essentially the same as that of needles 1 and 2.

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[a] See *Res. Dep. Terr. Mag.*, Vol. II, pp. 235–238.

TABLE 7A.—*Results of Declination Comparisons at the Helwan Observatory, 1918.*

Date	Local mean time		Declination obtained[1]		I. M. S.—Helwan	Station	
	From	To	I. M. S.	Helwan		C. I. W.	Helwan
1918	*h m*	*h m*	° ′	° ′	′		
July 12	8 24	8 31	−1 33.9	−1 34.9	+1.0	*Hut*	*N*
12	9 48	9 55	35.9	37.8	+1.9 (?)	*Hut*	*N*
12	10 52	10 59	37.6	39.1	+1.5	*Hut*	*N*
12	12 28	12 35	39.3	39.5	+0.2	*Hut*	*N*
12	17 10	17 17	36.3	37.7	+1.4	*N*	*Hut*
12	18 22	18 29	36.9	37.2	+0.3	*N*	*Hut*
19	8 14	8 21	34.2	34.4	+0.2	*Hut*	*N*
19	9 35	9 42	35.3	35.8	+0.5	*Hut*	*N*
19	10 11	10 18	37.3	37.8	+0.5	*N*	*Hut*
19	11 35	11 42	37.0	39.1	+2.1 (?)	*N*	*Hut*
19	16 38	16 45	38.5	38.8	+0.3	*N*	*Hut*
19	17 54	18 01	37.5	38.2	+0.7	*N*	*Hut*
26	7 59	9 06	32.2	33.2	+1.0	*Hut*	*N*
Mean value of (I. M. S.—Helwan, 1918) omitting values marked (?)...........................					+0.7		

[1] All values are referred to *N*; *N*=*Hut* +0′.6.

TABLE 7B.—*Results of Horizontal-Intensity Comparisons at the Helwan Observatory, 1918.*

Date	Local mean time		Hor. int. obtained[1]		I. M. S.—Helwan	Station	
	From	To	I. M. S.	Helwan		C. I. W.	Helwan
1918	*h m*	*h m*	γ	γ	γ		
July 12	8 41	9 38	29938	29961	−23	*Hut*	*N*
12	11 06	11 59	958	974	−16	*Hut*	*N*
12	17 22	18 14	924	946	−22	*N*	*Hut*
19	8 27	9 25	941	950	− 9	*Hut*	*N*
19	10 29	11 26	980	979	+ 1	*N*	*Hut*
19	16 49	17 40	948	954	− 6	*N*	*Hut*
26	9 12	10 05	925	925	0	*Hut*	*N*
Mean value of (I. M. S.—Helwan, 1918)...........					−10.7γ or −0.00036*H*		

[1] All values are referred to *N*; *N*=*Hut*+3γ.

TABLE 7C.—*Results of Inclination Comparisons at the Helwan Observatory, 1918.*

Date	Local mean time		Inclination obtained[1]		I. M. S.—Helwan	Station	
	From	To	I. M. S.	Helwan		C. I. W.	Helwan
1918	*h m*	*h m*	° ′	° ′	′		
July 14	15 59	17 04	+41 06.3	+41 04.5	+1.8	*Hut*	*S*
14	17 19	18 22	06.0	04.3	+1.7	*S*	*Hut*
15	17 31	18 40	06.2	05.2	+1.0	*Hutt*	*S*
24	16 55	17 51	06.0	04.7	+1.3	*S*	*Hut*
Mean value of (I. M. S.—Helwan, 1918).........					+1.4		

[1] All values are referred to *S*; *S*=*Hut*−0′.8.

SUMMARY.

Table 7D summarizes the chief results as already published in Volume II[a] and as given above.

[a] See *Res. Dep. Terr. Mag.*, Vol. II, pp. 235–238.

TABLE 7D.—*Summary of Corrections on Standards for Helwan Observatory.*

Date	(I. M. S.—Helwan)					
	Declination	Weight	Hor. int.	Weight	Inclination	Weight
	′				′	
1908, Apr.........	+0.4	1.0	+0.00018H(?)	0.0	+1.1	1.0
1911, May.........	+0.3	1.0	−0.00064H	1.0	+1.2	1.0
1914, Mar.........	+2.0(?)	0.0	−0.00048H	1.0	+0.9	1.0
1918, Jul..........	+0.7	1.0	−0.00036H	1.0	+1.4	1.0

It is to be noted that the results of the several comparisons are in substantial agreement with the results of previous comparisons as regards all 3 elements except for the declination-series of 1914 and for the intensity-series of 1908 which are rejected. As regards inclination all the Observatory results apply to the Observatory standard, viz, mean of needles 3 and 8, which is substantially the same as mean of needles 1 and 2 used prior to 1912. The Director of the Meteorological Service states in his letter of September 27, 1920: "Our inclination standard since November 1912 is the mean of values given by needles 3 and 8. Prior to that date our standard needles were 1 and 2, and at the time of changing over it was found that the 2 sets of needles gave so nearly identical results that no correction was considered necessary. Since that date several different needles have been in use, and the results given by them have all been reduced to the standard of 3 and 8. The correction applied to the mean of 10 and 11 to reduce to standard, the mean of 3 and 8, is −1′.8."

From Table 7D we obtain weighted mean values as follows:

(7) I. M. S.—Helwan (Elliott magnetometer No. 87) = +0′.5 (1908–1918).
(7*a*) I. M. S.—Helwan (Elliott magnetometer No. 87) = −0.00049H (1911–1918).
(7*b*) I. M. S.—Helwan (Dover dip circle No. 193, needles 3 and 8) = +1′.2 (1908–1918).

NO. 8.—HONGKONG OBSERVATORY, CHINA.

The comparisons of 1915 were obtained by Observers C. K. Edmunds and F. Brown, with the aid during part of the work of Director T. F. Claxton of the Observatory and of his assistants, Messrs. C. W. Jeffries and B. D. Evans. The same stations, viz, *A*, *A′*, and *B*, were occupied as for the comparisons of 1911.[a] Stations *A* and *A′* are the observing piers in the absolute house used regularly by the Observatory for the magnetometer and dip-circle work respectively; *A* (north pier) is 2.55 meters from *A′* (south pier). The station *B* is an outside or tent station 14.33 meters from *A′* and is located on the line between the latter and the azimuth mark used by the Observatory; the true bearing of the mark from stations *A* and *B*, as supplied by Director Claxton, is south 357° 51′.3 west. Some buildings were added near the stations subsequent to the observations of 1911; the new buildings may be largely responsible for the disagreements between the station-differences obtained in 1911 and in 1915.

The same observatory instruments, viz, Elliott magnetometer No. 55 and Dover dip circle No. 71 with needles 3, 4, 7, and 8, were used in these comparisons as in 1911. The C. I. W. instruments used were C. I. W. magnetometer No. 9 and Dover dip circle No. 177 with needles 1, 2, 5, and 6. The corrections on International Magnetic Standards[b] applied to results with the C. I. W. instruments are those finally adopted.

[a] See *Res. Dep. Terr. Mag.*, Vol. II, pp. 238–240. [b] See *Res. Dep. Terr. Mag.*, Vol. II, pp. 270–278.

The horizontal-intensity results for the Observatory were computed by the method explained in the report of Director Claxton for the year 1912.[a]

It was not possible to make all the comparison observations in declination and inclination simultaneously, since the urgency of other work restricted the available time of the Observatory staff. It was necessary, therefore, to obtain the comparisons in declination and inclination partly, as indicated in Tables 8A and 8C, by the less satisfactory method of alternate observations. The order of the alternate observations was made such that the mean times for each instrument for each individual correction on standard were practically the same; thus each determination of difference on standard by the method of alternate observations is based upon 2 complete determinations with the one instrument preceded and followed by a complete determination with the other instrument.

TABLE 8A.—*Results of Declination Comparisons at the Hongkong Observatory, 1915.*

Date	Local mean time		Declination obtained[1]		I. M. S.—Hongkong	Remarks
	From	To	I. M. S.	Hongkong		
1915	h m	h m	° ′	° ′	′	
Feb. 10	14 55	15 05	−0 10.0	−0 10.9	+0.9	Magnetometer No. 9 at *B*, Mr. Brown observing throughout; No. 55 at *A*, Mr. Jeffries observing set 1, Mr. Evans observing sets 2 to 7, and Director Claxton observing set 8.
12	11 28	11 42	09.7	09.9	+0.2	
12	11 52	12 04	09.9	10.1	+0.2	
13	10 02	10 16	09.9	10.8	+0.9	
13	10 33	10 47	09.9	10.6	+0.7	
13	11 10	11 24	09.8	10.0	+0.2	
13	11 39	11 54	09.6	09.8	+0.2	
13	15 13	15 33	08.3	09.1	+0.8	
21	15 08	15 49	08.8	09.8	+1.0	Magnetometer No. 9 at *A* and No. 55 at *B*, Mr. Brown used both instruments observing with each alternately.
21	15 57	16 42				
22	11 49	12 27	10.1	10.2	+0.1	
22	13 59	14 34				
22	14 41	15 18	09.2	09.2	0.0	
22	15 53	16 32				
22	16 38	17 15	07.5	08.8	+1.3	
22	17 21	17 53				
Mean value of (I. M. S.—Hongkong 55).........					+0.5	

[1] All values are referred to station *A*; $A = B + 4'.7$.

TABLE 8B.—*Results of Horizontal-Intensity Comparisons at the Hongkong Observatory, 1915.*

Date	Local mean time		Hor. int. obtained[1]		I. M. S.—Hongkong	Remarks
	From	To	I. M. S.	Hongkong		
1915	h m	h m	γ	γ	γ	
Feb. 24	11 08	15 52	37213	37192	+21	Magnetometer No. 9 at *A*, Mr. Brown observing; No. 55 at *B*, Mr. Edmunds observing.
24	16 06	17 09	189	137	+52[2]	
25	8 44	11 36	215	190	+25	Magnetometer No. 9 at *B*, Mr. Brown observing; No. 55 at *A*, Mr. Edmunds observing.
25	11 53	15 56	215	189	+26	
25	16 02	17 08	212	157	+55[2]	
Mean value of (I. M. S.—Hongkong 55)..........					+31.4γ or +0.00084*H*	

[1] All values are referred to *A*; $A = B - 29.1\gamma$. [2] Half set; weight 0.5.

[a] Report of the Director of the Royal Observatory, Hongkong, for the year 1912, p. 2, Hongkong, 1913.

TABLE 8C.—*Results of Inclination Comparisons at the Hongkong Observatory, 1915.*

Date	Local mean time From	Local mean time To	Inclination obtained[1] I. M. S.	Inclination obtained[1] Hongkong	I. M. S.—Hongkong	Remarks
1915	h m	h m	° ′	° ′	′	
Feb. 15	8 44	12 25	+30 51.0	+30 52.8	−1.8	D. C. No. 177 at *B*; No. 71 at *A′*. Mr. Brown used both instruments observing with each alternately.
15	13 55	17 24				
16	8 52	12 15	50.8	52.5	−1.7	
16	13 51	17 09				
17	10 28	12 01	49.1	50.7	−1.6	D. C. No. 177 at *A′*, Mr. Brown observing throughout; No. 71 at *B*.[2]
18	10 17	11 41	50.8	53.6	−2.8	
18	14 19	15 51	51.5	53.3	−1.8	
19	8 44	11 54	50.6	51.6	−1.0	
19	13 53	16 53				
Mean value of (I. M. S.—Hongkong 71).........					−1.8	

[1] All values are referred to A'; $A'=B+1'.3$.

[2] The observations with the 2 instruments on February 17 and 18 were simultaneous, Mr. Evans observing the first and second sets and Mr. Jeffries the third set with No. 71. Mr. Brown used both instruments on February 19 observing with each alternately.

SUMMARY.

Table 8D summarizes the chief results as already published in Volume II[a] and as given above.

TABLE 8D.—*Summary of Corrections on Standards for Hongkong Observatory.*

Date	(I. M. S.—Hongkong) Declination	Weight	Hor. int.	Weight	Inclination	Weight
	′				′	
1907, Aug.........	.....	...	+0.00075*H*	1.0	.....	...
1908, Dec.........	+0.6	1.0	+0.00205*H*	1.0	.....	...
1911, Mar.........	.....	...	....	...	+0.2	1.0
1911, Jun......... Jul..........	+1.2	4.0	+0.00105*H*	3.0	.....	...
1915, Feb.........	+0.5	2.0	+0.00084*H*	2.0	−1.8	1.0

Hence we obtain weighted mean values as follows:

(8) I. M. S.—Hongkong (Elliott magnetometer No. 55) = +0′.9 (1908–1915).
(8*a*) I. M. S.—Hongkong (Elliott magnetometer No. 55) = +0.00109*H* (1907–1915).
(8*b*) I. M. S.—Hongkong (Dover dip circle No. 71, needles 3 4, 7, 8) = −0′.8 (1911–1915).

NO. 9.—HONOLULU OBSERVATORY, HAWAII.

SERIES I, 1915.

Comparison observations were obtained during May 27 to June 22, 1915, by the *Carnegie* party at the Honolulu Magnetic Observatory near Sisal, Oahu Island, Hawaii. This observatory is operated by the United States Coast and Geodetic Survey. Three stations were occupied: *Absolute Observatory*, the pier in the absolute observatory regularly used for absolute work; *A*, 18.46 meters due north of the station *Absolute Observatory* and 6.4 meters beyond a stone fence surrounding the Observatory inclosure, and *B*, 12.50 meters south 32°.7 west of the southwest corner of the absolute observatory and 18.01 meters east 1°.2 south of the southeast corner of the entrance-vestibule of the variation-observatory building. When C.I.W. earth-inductor No. 3 was used at the station *Absolute Observatory*, it was mounted on a framework 20 cm. above the center of the pier since, for this instrument, the rotating device for the coil requires a free space below the instrument. It has been assumed that for this change in elevation there is

[a] See *Res. Dep. Terr. Mag.*, Vol. II, pp. 238–240.

no appreciable difference in the absolute value of inclination for this station; this assumption is borne out by the agreement for the differences on the observatory instrument resulting from the comparisons with the 2 C. I. W. earth-inductors. The station-differences were determined by the method of simultaneous observations and exchange of stations.

The standard instrument of the Observatory for declination and horizontal intensity is U. S. C. & G. S. magnetometer No. 36, by Cooke and Sons; this instrument is substantially the Magnetic Survey of India pattern. The standard instrument of the Observatory for inclination is Schulze earth-inductor U. S. C. & G. S. No. 4, of the Wild-Eschenhagen pattern. The corrections applied to observed values to refer these values to the standards of the United States Coast and Geodetic Survey, supplied by Mr. W. W. Merrymon, observer-in-charge at the Observatory, were: for magnetometer No. 36 in declination, $-0'.4$, and in horizontal intensity, $0.00000H$; for earth inductor No. 4 in inclination, $-0'.26$. The instruments used by the members of the *Carnegie* staff were C.I.W. theodolite-magnetometer No. 5, C.I.W. magnetometer-inductor No. 25, and C.I.W. marine earth-inductor No. 3. The finally adopted corrections on I.M.S. have been applied for all C.I.W. instruments.

The observations were all made as nearly simultaneous as possible. Mr. Merrymon carried out all of the observations with the U. S. C. & G. S. instruments and Messrs. Edmonds and Luke, under the direction of Captain J. P. Ault of the *Carnegie*, those with the C.I.W. instruments.

The azimuths used for the declination work were as follows: station *Absolute Observatory*, north meridian mark of the Observatory about 2,800 feet distant, 180° 00'.0, and a telephone-pole about 750 feet distant, 180° 24'.3; station *A*, north meridian mark of the Observatory, 180° 00'.0, and telephone-pole (same as used for *Absolute Observatory*), 180° 26'.2. The azimuths for the telephone-pole from the 2 stations were determined by angular measurements from the north meridian-mark of the Observatory. At station *B* the azimuth mark used was a second telephone-pole about 650 feet distant, true bearing of which, from an extended series of Sun observations, was 184° 41'.6.

Stations *A* and *B* are on coral rock, which is easily pulverized by walking about. As a result, there is a great deal of fine dust constantly in the air, and the observers experienced considerable difficulty on this account when working at these 2 stations. This was particularly the case for the observations with the earth inductors, and for this reason the comparisons between earth inductors were limited to the stations *Absolute Observatory* and *A*. Another source of trouble at the outside stations was the sudden temperature changes due to passing clouds; variations of as great as 5° Centigrade were noted in intervals as short as 5 minutes.

SERIES II, 1921.

Comparison observations were again obtained during April 15 to 25, 1921, by the *Carnegie* party. The stations *Absolute Observatory* and *A* of 1915 were reoccupied. The standard instruments of the Observatory, their corrections (except for declination) on Coast and Geodetic Survey standards, azimuth marks, and azimuths, were the same as for Series I. The instruments used by the members of the *Carnegie* staff were as in Series I. The finally adopted corrections on I.M.S. have been applied for all C.I.W. instruments.

The Director of the United States Coast and Geodetic Survey referring to these comparisons in his letter of August 10, 1921, says:

"The declination observations with No. 36 appear to have been unreliable for some reason and it has been deemed advisable to use values of declination obtained from the magnetograph, using the mean base-line value. It should be noted that at the time the new observer took charge

TABLE 9A.—*Results of Declination Comparisons at the Honolulu Observatory, 1915.*

Date	Local mean time		Declination obtained[1]		I. M. S.—Honolulu	Remarks
	From	To	I. M. S.	Honolulu		
1915	h m	h m	° ′	° ′	′	
May 27	10 20	10 28	+9 42.5	+9 42.0	+0.5	C. I. W. No. 5 at *B;* C. I. W. No. 25 at *A;* C. & G. S. No. 36 at *Absolute Observatory.*
27	12 58	13 07	40.5	40.8	−0.3	
27	15 53	16 02	42.1	42.4	−0.3	
27	17 56	18 05	41.0	41.3	−0.3	
28	7 50	7 59	43.7	43.9	−0.2	
28	10 56	11 05	38.6[2]	39.1	−0.5	
28	11 23	11 32	38.5	38.0	+0.5	
28	14 40	14 49	39.7	39.8	−0.1	
June 3	9 50	9 59	42.3	42.9	−0.6	C. I. W. No. 5 at *Absolute Observatory;* C. I. W. No. 25 at *B*; C. & G. S. No. 36 at *A*.
3	11 59	12 08	40.1	40.4	−0.3	
3	13 50	13 59	40.6	40.7	−0.1	
3	15 57	16 06	41.3	41.2	+0.1	
3	16 27	16 36	41.4	41.3	+0.1	
3	18 29	18 38	41.5	41.1	+0.4	
4	9 44	9 53	43.6	43.6	0.0	C. I. W. No. 5 at *A*; C. I. W. No. 25 at *Absolute Observatory;* C. & G. S. No. 36 at *B*.
4	11 58	12 07	40.3	41.1	+0.2	
4	12 25	13 34	39.7	40.3	−0.6	
4	16 13	16 22	40.4	40.4	0.0	
4	16 43	16 52	40.7	40.2	+0.5	
5	9 13	9 21	43.3	42.9	+0.4	
5	9 25	9 34	43.3	42.8	+0.5	
Mean value of (I. M. S.—Honolulu)............					0.0	(weight, 2.0)

[1] All values are referred to station *Absolute Observatory*; *Absolute Observatory*$=A+0'.3=B-0'.3$ as determined from this series.
[2] Value by C. I. W. 25 appears in error and is rejected, value given being that determined by No. 5 only.

TABLE 9B.—*Results of Horizontal-Intensity Comparisons at the Honolulu Observatory, 1915.*

Date	Local mean time		Hor. int. obtained[1]		I. M. S.—Honolulu	Remarks
	From	To	I. M. S.	Honolulu		
1915	h m	h m	γ	γ	γ	
May 27	10 37	12 50	29008	29006	+ 2	C. I. W. No. 5 at *B*; C. I. W. No. 25 at *A*; C. & G. S. No. 36 at *Absolute Observatory.*
27	16 05	17 42	8994	8989	+ 5	
28	9 02	10 49	9014	9013	+ 1	
28	11 34[2]	14 34	9020	9022	− 2	
June 3	10 05	11 52	9025	9026	− 1	C. I. W. No. 5 at *Absolute Observatory;* C. I. W. No. 25 at *B;* C. & G. S. No. 36 at *A*.
3	14 02	15 50	9026	9027	− 1	
3	16 39	18 27	9012	9016	− 4	
4	9 55	11 55	9012	9015	− 3	C. I. W. No. 5 at *A*; C. I. W. No. 25 at *Absolute Observatory;* C. & G. S. No. 36 at *B*
4	14 30	16 07	9019	9017	+ 2	
4	16 55	17 52	9025	9010	+15	
5	8 20	9 10				
Mean value of (I. M. S.—Honolulu).............					+ 1.4γ or +0.00005*H* (weight, 1.5)	

[1] All values are referred to station *Absolute Observatory*; *Absolute Observatory*$=A+10.2\gamma=B-8.0\gamma$ as determined from this series.
[2] Time interval from ending of first half set to beginning of second half set $12^h\ 20^m$ to $13^h\ 47^m$.

of the Observatory in 1916, some change in the method of observing or in the condition of the magnetometer produced a change of 0′.7 in the resulting values of declination. Consequently since that time a correction of −1′.1 has been applied instead of the −0′.4 used previous to that time.

"In the horizontal-intensity comparison observations made by Mr. McComb three deflection distances were used, but it has been considered preferable to use the results only from the two distances used ordinarily in the Observatory work.

"No satisfactory explanation has been made of the change in the relation of the auxiliary station and the absolute-observatory pier, particularly in the case of horizontal intensity. The stub marking the old station was found in place and, so far as known, no change in the immediate surroundings was made between 1915 and 1921."

TABLE 9C.—*Results of Inclination Comparisons at the Honolulu Observatory, 1915.*

Date	Local mean time		Inclination obtained[1]		I. M. S.—Honolulu	Remarks
	From	To	I. M. S.	Honolulu		
1915	h m	h m	° ′	° ′	′	
June 18	13 46	14 03	+39 33.4	+39 33.7	−0.3	
18	14 25	14 46	34.1	33.6	+0.5	
18	15 21	15 41	33.7	33.9	−0.2	C. I. W. inductor No. 3 at *A*; C. & G. S. inductor No. 4 at *Absolute Observatory.*
18	15 56	16 16	33.8	33.7	+0.1	
18	16 43	17 03	33.9	34.0	−0.1	
18	17 21	17 43	33.8	34.1	−0.3	
19	16 25	16 43	32.6	32.4	+0.2	
19	12 18	12 39	31.5	32.2	−0.7	
19	13 34	13 52	31.5	32.5	−1.0	
19	14 11	14 30	31.7	32.2	−0.5	C. I. W. inductor No. 25 at *A*; C. & G. S. inductor No. 4 at *Absolute Observatory.*
19	14 40	14 57	31.8	32.1	−0.3	
19	15 18	15 36	32.0	32.2	−0.2	
19	15 47	16 04	32.2	32.4	−0.2	
21	12 04	12 23	30.2	30.2	0.0	
21	13 33	13 55	31.4	31.8	−0.4	
21	14 21	14 47	31.7	32.0	−0.3	C. I. W. inductor No. 25 at *Absolute Observatory;* C. & G. S. inductor No. 4 at *A*.
21	14 56	15 15	31.9	32.4	−0.5	
21	15 43	16 01	32.3	32.4	−0.1	
21	16 09	16 25	32.1	32.3	−0.2	
22	13 36	13 51	29.3	30.1	−0.8	
22	14 05	14 20	30.0	30.5	−0.5	
22	14 40	14 58	30.3	30.8	−0.5	
22	15 03	15 17	30.6	30.8	−0.2	C. I. W. inductor No. 3 at *Absolute Observatory;* C. & G. S. inductor No. 4 at *A*.
22	16 21	16 37	31.4	31.3	+0.1	
22	16 40	17 01	31.6	31.4	+0.2	
22	17 21	17 39	31.8	31.9	−0.1	
22	17 48	18 03	32.1	31.9	+0.2	
Mean value of (I. M. S.—Honolulu)............					−0.2	(weight, 1.5)

[1] All values are referred to station *Absolute Observatory; Absolute Observatory* = *A*−0′.6 as determined from this series.

The observations were made as nearly simultaneous as possible. Mr. H. E. McComb, observer-in-charge at the Observatory, carried out all the observations with the U. S. C. & G. S. instruments, and Messrs. Johnston and Grummann, under the direction of Captain J. P. Ault of the *Carnegie*, those with the C.I.W. instruments. C. & G. S. galvanometer was used for all inside earth-inductor observations and C.I.W. galvanometer for all outside observations.

TABLE 9D.—*Results of Declination Comparisons at Honolulu Observatory, 1921.*

Date	Local mean time		Declination obtained[1]		I. M. S.—Honolulu	Remarks
	From	To	I. M. S.	Honolulu[2]		
1921	h m	h m	° ′	° ′	′	
April 19	8 38	8 47	+9 57.3	+9 57.5	−0.2	
19	8 51	9 00	56.8	56.7	+0.1	
19	9 21	9 30	54.8	54.9	−0.1	C. I. W. No. 5 at *Absolute Observatory;* C. & G. S. No. 36 at *A*.
19	9 32	9 41	54.1	54.3	−0.2	
19	10 00	10 09	52.7	52.8	−0.1	
19	10 11	10 20	52.6	52.5	+0.1	
20	7 50	7 59	60.1	60.4	−0.3	
20	8 01	8 10	60.5	61.0	−0.5	
20	8 30	8 39	61.1	61.2	−0.1	
20	8 41	8 50	60.8	60.7	+0.1	C. I. W. No. 5 at *A*; C. & G. S. No. 36 at *Absolute Observatory.*
20	9 11	9 20	58.9	58.8	+0.1	
20	9 22	9 35	57.9	58.1	−0.2	
21	8 06	8 15	59.2	59.4	−0.2	
Mean value of (I. M. S.—Honolulu)............					−0.1	(weight, 1.0)

[1] All values are referred to station *Absolute Observatory; Absolute Observatory* = *A*−0′.0 (see foot-note 2).
[2] The observations with C. & G. S. No. 36 at *Absolute Observatory* appear to be defective judging from the base-line values, and the Observatory values have therefore been derived from the magnetograph, using a mean base-line value, 9°27′.6, which depends upon other observations with No. 36 corrected by −1′.1. The base-line values from C. I. W. No. 5 come out the same for both stations and the station-difference between *Absolute Observatory* and *A* is therefore assumed to be zero for declination.

TABLE 9E.—*Results of Horizontal-Intensity Comparisons at Honolulu Observatory, 1921.*

Date	Local mean time		Hor. int. obtained[1]		I. M. S.—Honolulu	Remarks
	From	To	I. M. S.	Honolulu		
1921	h m	h m	γ	γ	γ	
April 15	9 12	10 43	28812	28816	− 4	C. I. W. No. 5 at *A*; C. & G. S. No. 36 at *Absolute Observatory*.
15	13 40	15 04	828	826	+ 2	
18	10 48	12 14	884	891	− 7	C. I. W. No. 5 at *Absolute Observatory;* C. & G. S. No. 36 at *A*.
18	15 00	16 15	869	867	+ 2	
19	14 12	15 24	821	827	− 6	
25	8 24	9 47	853	863	−10	C. I. W. No. 5 at *A*; C. & G. S. No. 36 at *Absolute Observatory*.
25	14 46	16 09	829	833	− 4	
Mean value of (I. M. S.—Honolulu)............					− 3.9γ or −0.00014*H* (weight, 1.0)	

[1] All values are referred to station *Absolute Observatory*; *Absolute Observatory* = *A* +20.5γ, as determined from this series.

TABLE 9F.—*Results of Inclination Comparisons at Honolulu Observatory, 1921.*

Date	Local mean time		Inclination obtained[1]		I. M. S.—Honolulu	Remarks
	From	To	I. M. S.	Honolulu		
1921	h m	h m	° ′	° ′	′	
April 20	13 10	13 20	+39 25.2	+39 24.5	+0.7	C. I. W. inductor No. 25 at *A*; C. & G. S. inductor No. 4 at *Absolute Observatory*.
20	14 18	14 28	27.0	26.3	+0.7	
20	14 46	14 58	27.5	26.8	+0.7	
20	15 16	15 26	28.4	27.0	?	
20	15 42	15 52	28.2	27.5	+0.7	
20	16 44	16 54	28.6	28.2	+0.4	
20	17 08	17 18	28.9	28.3	+0.6	
21	9 10	9 42	25.0	24.2	+0.8	C. I. W. inductor No. 25 at *Absolute Observatory;* C. & G. S. inductor No. 4 at *A*.
21	10 06	10 26	24.0	23.6	+0.4	
21	10 38	11 02	23.8	23.3	+0.5	
21	13 52	14 06	24.7	24.0	+0.7	
21	14 22	14 32	25.1	24.4	+0.7	
21	14 56	15 12	26.3	25.7	+0.6	
Mean value of (I. M. S.—Honolulu)..........					+0.6	(weight, 1.0)

[1] All values are referred to station *Absolute Observatory*; *Absolute Observatory* = *A* −0′.2, as determined from this series.

SUMMARY.

The following weighted mean values result from the above series I and II:

(9) I. M. S.—Honolulu (Cooke magnetometer C. & G. S. No. 36[a]) = 0′.0 (1915–1921).
(9*a*) I. M. S.—Honolulu (Cooke magnetometer C. & G. S. No. 36) = −0.00003*H* (1915–1921).
(9*b*) I. M. S.—Honolulu (Schulze inductor C. & G. S. No. 4−0′.26) = +0′.1 (1915–1921).

NO. 10.—KEW OBSERVATORY, ENGLAND.

SERIES I AND II, 1915.

The comparisons of 1915 were obtained by Dr. C. Chree, Superintendent, and Mr. B. Francis, Magnetic Observer, of the Observatory staff, and Observer E. Kidson of the Carnegie Institution of Washington. The observations were made in the old and new absolute-houses in each of which there are 3 piers lying in an east-west line; only the middle and west piers in each house were used. The stations in the old absolute-house have been designated O_m and O_w, and those in the new absolute-house have been designated N_m and N_w, the subscripts *m* and *w* designating respectively the middle and west piers in each case. The declination and horizontal-intensity observations were made on the piers O_m and N_m; O_m is the station used regularly for the Observatory determinations of declination and horizontal intensity. The inclination observations were made on the piers O_w and N_w; N_w is the station used regularly for the Observatory inclination-

[a] See page 432 with reference to corrections adopted for declination to obtain Observatory standard.

determinations. The two Observatory azimuth marks, each consisting of a white line between two black rectangles on an obelisk in the Park, were used, the upper one for the station N_m, and the lower one for the station O_m; the true bearings, supplied by Dr. Chree, were 182° 06′.3 and 182° 48′.7 west of south, respectively.

The Observatory absolute-instruments used were the Kew unifilar magnetometer by Jones and the Kew dip circle No. 33 with 2 needles by Barrow. These are the same instruments[a] as those compared previously[b] except for modifications made during 1914 in the magnetometer, the horizontal circle having been redivided[c] and a two-vernier system having been substituted for the three-vernier system. Owing to the development of a trace of rust on the magnet of the Kew magnetometer in 1914, a redetermination of the moment of inertia was made by the Observatory authorities. The new value of the moment of inertia has been utilized in determining the Kew values given in Table 10B (intensities calculated using the old value of the moment of inertia found in 1910 required to be reduced by 5 gammas when the new value was used). The Kew intensity values depend upon the distribution coefficients finally adopted by Dr. Chree. The C. I. W. instrument used was magnetometer-inductor No. 26. For those comparisons which are based upon data from the magnetograms the base-line values depend upon absolute observations with the Observatory instruments designated above. The corrections on International Magnetic Standards,[d] applied to results obtained with magnetometer-inductor No. 26, were those finally adopted for that instrument.

The electric-tram service affects both the absolute observations and the magnetograph records at the Observatory. The vertical-intensity magnetograms are badly disturbed on this account. The values of (I. M. S.—Kew) given in Tables 10A, 10B, and 10C are based on the assumption that the station-differences, if any, are negligible. This assumption is borne out by the simultaneous absolute-observations, involving exchange of stations, which indicated the station-differences were of an order less than that of the errors to be expected in the observations. Furthermore, the effects of any possible station-differences are practically eliminated in the means because exchanges of stations were made in each series.

It will be noted that the value determined in August and October 1915 for (I. M. S. —Kew) = $-0.00047H$ is materially different from the mean value determined in 1908 and 1910, viz, $+0.00007H$.[e] That there was a real change of the order shown appears to be indicated through indirect comparisons.

In February, June, and July 1915 comparisons were made at Kew between the Kew standard and magnetometer No. 83 of the Hongkong Observatory. Magnetometer No. 83 had been sent to England in February 1914 and alterations and repairs completed prior to these comparisons. Director Claxton of the Hongkong Observatory, in his report[f] for the year 1915, gives mean result (Kew—Hongkong No. 83) = $+30\gamma$; this published value, Director Claxton states in his letter of January 19, 1917, must be corrected because of finally adopted distribution coefficients and moment of inertia at Kew (see Series I and II above) by -8γ, whence we have:

(*a*) Kew—Hongkong No. 83 = $+22\gamma$ (at Kew in 1915) = $+0.00119H$.

After the return of No. 83 to Hongkong, comparisons between Elliott No. 55, the

[a] Dr. Chree notes, however, in a letter dated August 7, 1915, that the average difference between Barrow circle No. 33 and modern Dover circles has apparently been a trifle less since he succeeded Mr. Baker, who retired at the end of September 1912, as principal dip observer.

[b] See *Res. Dep. Terr. Mag.*, Vol. II, pp. 240–243.

[c] Dr. Chree states that a very careful examination of both the declination and horizontal-intensity base-values obtained before and after the circle was redivided led to the conclusion that no appreciable change has been made so far as the numerical values of either declination or horizontal intensity are concerned.

[d] See *Res. Dep. Terr. Mag.*, Vol. II, pp. 270–278.

[e] See *Res. Dep. Terr. Mag.*, Vol. II, p. 241.

[f] Claxton, T. F., Report of the Director of the Royal Observatory, Hongkong, for the year 1915, Hongkong, 1916.

TABLE 10A.—*Results of Declination Comparisons at the Kew Observatory, 1915.*

Series	Date	Local mean time From	Local mean time To	Declination obtained I. M. S.	Declination obtained Kew	I. M. S.—Kew	Remarks
	1915	h m	h m	° ′	° ′	′	
I	Aug. 6	14 47	14 56	−15 22.5	−15 22.6	+0.1	C. I. W. magnetometer No. 26 at N_m; Kew Jones magnetometer at O_m.
	6	15 08	15 17	22.1	22.4	+0.3	
	6	15 43	15 52	20.5	20.6	+0.1	
	6	15 58	16 07	19.8	20.0	+0.2	
	6	16 26	16 35	19.8	19.8	0.0	
	6	16 41	16 50	19.6	19.6	0.0	
	9	14 17	14 26	24.9	25.0	+0.1	C. I. W. magnetometer No. 26 at O_m; Kew Jones magnetometer at N_m.
	9	14 34	14 43	24.7	24.7	0.0	
	9	14 56	15 05	23.9	23.9	0.0	
	9	15 11	15 20	23.1	23.4	+0.3	
	9	15 42	15 51	21.1	21.6	+0.5	
	9	16 06	16 15	20.7	20.8	+0.1	
	10	10 13	10 22	16.0	16.4	+0.4	C. I. W. magnetometer No. 26 at O_m; Kew values from magnetograms.
	10	12 18	12 27	23.5	23.5	0.0	
	10	12 48	12 55	24.7	24.5	−0.2	
	10	14 24	14 31	24.5	24.4	−0.1	
	11	11 41	11 48	23.5	23.6	+0.1	C. I. W. magnetometer No. 26 at N_m; Kew values from magnetograms.
	11	13 46	13 53	26.1	25.6	−0.5	
Mean						+0.08	
	1915						
II	Oct. 6	14 15	14 24	−15 20.3	−15 20.2	−0.1	C. I. W. magnetometer No. 26 at N_m; Kew Jones magnetometer at O_m.
	6	14 31	14 40	20.0	19.9	−0.1	
	6	14 51	15 00	19.9	19.9	0.0	
	6	15 07	15 16	19.9	19.6	−0.3	
	6	15 28	15 37	19.0	19.0	0.0	
	6	15 48	15 57	18.1[1]	18.5	.....	
	13	13 52	14 01	21.7	21.5	−0.2	C. I. W. magnetometer No. 26 at O_m; Kew Jones magnetometer at N_m.
	13	14 09	14 18	21.9	21.6	−0.3	
	13	14 28	14 37	21.2	21.0	−0.2	
	13	14 46	14 55	20.1	20.2	+0.1	
	13	15 06	15 15	19.7	19.2	−0.5	
	13	15 23	15 32	18.8	18.6	−0.2	
Mean						−0.16	
Mean value of (I. M. S.—Kew) from I and II						0.0	

[1] This observation is rejected because magnet 26L was inadvertently rotated in its stirrup 90° from its proper position.

standard instrument at Hongkong, and Elliott No. 83 gave from 4 determinations made in December 1916 (using a home-made variometer to reduce to a common reading), according to Director Claxton's letter of January 19, 1917,

(*b*) Hongkong No. 83—Hongkong standard No. 55 = $+22\gamma$ (at Hongkong) = $+0.00059H$.

Hence from (*a*) and (*b*) we have:

(*c*) Kew—Hongkong No. 55 = $+0.00178H$,

From the compilation of comparisons at Hongkong Observatory (see p. 431) we have

(*d*) I. M. S.—Hongkong No. 55 = $+0.00109H$,

whence:

(*e*) I. M. S.—Kew = $-0.0007H$.

A second indirect check is to be had through comparisons at Kew during October and November 1914 of Cooke magnetometer No. 40 purchased by the United States Coast and Geodetic Survey and subsequently compared at Cheltenham Observatory. The comparisons (6 sets) during October and November 1914 at Kew, when referred

TABLE 10B.—*Results of Horizontal-Intensity Comparisons at the Kew Observatory, 1915.*

Series	Date	Local mean time[1]		Hor. int. obtained		I. M. S.—Kew	Remarks
		From	To	I. M. S.	Kew		
	1915	h m	h m	γ	γ	γ	
I	Aug. 9	9 50	11 24	18427	18441[2]	−14	C. I. W. magnetometer No. 26 at O_m; Kew Jones magnetometer at N_m.
	9	11 31	12 49	32	45[2]	−13	
	10	10 30	12 12	25	31[3]	− 6	C. I. W. magnetometer No. 26 at O_m; Kew values from magnetogram.
	10	12 57	14 22	38	50[3]	−12	
	11	11 51	13 43	38	47[3]	− 9	C. I. W. magnetometer No. 26 at N_m; Kew value from magnetogram.
	12	9 53	11 09	25	34[2]	− 9	C. I. W. magnetometer No. 26 at N_m; Kew Jones magnetometer at O_m.
	12	11 17	12 28	33	41[2]	− 8	
	12	14 00	15 17	48	56[2]	− 8	
Mean						− 9.9[4] = −9.4γ (weight, 2)	
	1915						
II	Oct. 7	10 12	11 31	18442	18450[2]	− 8	C. I. W. magnetometer No. 26 at N_m; Kew Jones magnetometer at O_m.
	7	11 40	12 47	44	52[2]	− 8	
	14	10 04	11 23	29	36[2]	− 7	C. I. W. magnetometer No. 26 at O_m; Kew Jones magnetometer at N_m.
	14	11 30	12 48	35	43[2]	− 8	
Mean						− 7.8[4] = −7.3γ (weight, 1)	
Weighted mean value of (I. M. S.—Kew)						− 9.2γ[4] = −8.7γ or −0.00047H when corrected for final values Kew distribution coefficients.	

[1] Times given apply to C. I. W. observations.

[2] These values result from observations not strictly simultaneous with the C. I. W. observations but reduced to the times of the C. I. W. observations by reference to the magnetograms.

[3] These values are scaled from the magnetograms which were standardized by the observations of August 9 and 12 with Jones unifilar magnetometer.

[4] The Kew values are rounded off to the nearest γ in application of correction for revised values of distribution coefficients for 1915; Dr. Chree states that the values for (I. M. S.—Kew) become 0.5γ less when correction is made on this account.

to final values of distribution coefficient and moment of inertia for No. 40 as determined by the Coast and Geodetic Survey, give, after applying correction of −5γ to Kew results to correct for new value of inertia (see p. 436):

(*a*) Kew—C. & G. S. No. 40 = +7γ at Kew = +0.00038H.

Fifteen and one-half sets of comparisons during February, March, and November 1915 gave, according to data supplied by Director E. Lester Jones of the Coast and Geodetic Survey:

(*b*) Cheltenham—C. & G. S. No. 40 = +0.00001H.

From (*a*) and (*b*) we have:

(*c*) Cheltenham—Kew = −0.00037H.

Since from page 407

(d) I. M. S.—Cheltenham = −0.00006H,

we have

(*e*) I. M. S.—Kew = −0.00043H,

which is in substantial agreement with the value directly determined at Kew by Series I and II of 1915, viz, −0.00047H.

SERIES III, 1919.

This series was obtained by Observer F. Brown during April 1 to 4, 1919, prior to his departure for field work in Africa. Because of the scant time at his disposal and because of other demands upon the time of the Observatory staff complete intercom-

TABLE 10C.—*Results of Inclination Comparisons at the Kew Observatory, 1915.*

Series	Date	Local mean time[1]		Inclination obtained		I. M. S.—Kew	Remarks
		From	To	I. M. S.	Kew[2]		
	1915	h m	h m	° ′	° ′	′	
I	Aug. 25	12 50	13 05	+66 56.1	+66 55.8	+0.3	C. I. W. magnetometer-inductor No. 26 at O_w; Kew dip circle No. 33 at N_w (3 complete determinations).
	25	13 14	13 28	55.8	55.8	0.0	
	25	14 20	14 34	55.6	55.6	0.0	
	25	14 36	14 49	55.6	55.6	0.0	
	25	15 01	15 12	55.5	55.5	0.0	
	25	15 16	15 28	55.1	55.2	−0.1	
	25	15 39	15 54	56.2	56.0	+0.2	
	25	15 56	16 08	56.4	56.6	−0.2	
	25	16 16	16 31	55.7	55.6	+0.1	
	25	16 34	16 44	55.3	55.2	+0.1	
	26	14 49	15 01	57.8	58.6	−0.8	C. I. W. magnetometer-inductor No. 26 at N_w; Kew dip circle No. 33 at O_w (3 complete determinations).
	26	15 04	15 20	58.0	58.1	−0.1	
	26	15 44	15 56	57.7	57.9	−0.2	
	26	15 58	16 10	57.3	57.7	−0.4	
	26	16 45	16 56	56.9	57.5	−0.6	
	26	16 57	17 08	56.7	57.2	−0.5	
	Mean.......					−0.15	
	1915						
II	Oct. 7	13 58	14 13	+66 55.8	+66 55.4	+0.4	C. I. W. magnetometer-inductor No. 26 at O_w; Kew dip circle No. 33 at N_w (2 complete determinations).
	7	14 15	14 27	55.7	55.3	+0.4	
	7	14 43	14 58	56.1	55.9	+0.2	
	7	15 00	15 12	56.2	56.0	+0.2	
	7	15 18	15 30	56.1	55.7	+0.4	
	14	13 57	14 11	55.8	55.9	−0.1	C. I. W. magnetometer-inductor No. 26 at N_w; Kew dip circle No. 33 at O_w (2 complete determinations).
	14	14 14	14 28	56.5	57.1	−0.6	
	14	14 30	14 42	56.7	57.2	−0.5	
	14	14 58	15 11	58.1	58.2	−0.1	
	14	15 12	15 25	59.0	59.4	−0.4	
	14	15 29	15 41	59.2	59.9	−0.7	
	Mean.......					−0.07	
	Mean value of (I. M. S.—Kew) from I and II.......					−0.1	

[1] Times given apply to C. I. W. observations (see foot-note 2).
[2] The Kew values were derived from the horizontal-intensity and vertical-intensity magnetograms allowance being made for the departures from the mean values of the horizontal intensity and of the vertical intensity corresponding to the observed inclinations determined on each day, as indicated in the column of remarks, by Dr. Chree with the Kew dip circle No. 33.

parisons with interchange of stations could not be obtained except for the inclination work, the declination and horizontal-intensity comparisons depending upon magnetograph data. The C. I. W. stations were all in the new absolute house, the east pier, N_e, and west pier, N_w, being used for the inclination observations, and the center pier, N_m, being used for the declination and horizontal-intensity observations; N_e was not occupied in the two series of 1915. The azimuth mark used was, as in 1915, the obelisk in the Park; its true bearing, as supplied by Dr. Chree, being 182° 06′.3 west of south. Dr. Chree stated that tests showed there was no sensible station-difference between the piers of the new and old absolute houses.

The absolute instruments of the Observatory were as for the two series in 1915; the simultaneous inclination observations with the Observatory Barrow dip circle were made by Dr. Chree. The C. I. W. instruments were magnetometer No. 13 and dip circle No. 177 with needles 13X and 16X (needles 14X and 15X were also used on April 1 in tests to select the better pair for use in the comparisons). The corrections on International Magnetic Standards[a] applied to the C. I. W. results are those tentatively adopted (see pp. 10 and 15) pending return and restandardization at Washington, probably sometime in 1922.

[a] See *Res. Dep. Terr. Mag.*, Vol. II, pp. 270-278.

TABLE 10D.—*Results of Declination Comparisons at the Kew Observatory, 1919.*

Date	Local mean time		Declination obtained[1]		I. M. S.—Kew	Remarks
	From	To	I. M. S.	Kew		
1919	*h m*	*h m*	° ′	° ′	′	
April 2	11 16	11 25	−14 47.4	−14 47.8	+0.4	C. I. W. magnetometer No. 13 at N_m; Kew data are from magnetograms based on Kew Jones magnetometer observations at O_m.
2	12 48	12 57	51.6	51.6	0.0	
2	16 47	16 54	44.9	45.1	+0.2	
3	8 22	8 31	36.9	37.4	+0.5	
3	10 58	11 05	42.9	43.7	+0.8	
3	11 45	11 54	46.6	47.0	+0.4	
3	16 52	16 59	46.2	46.3	+0.1	
Mean value of (I. M. S.—Kew)					+0.34	

[1] It is assumed that any station-difference between piers N_m and O_m is negligible.

TABLE 10E.—*Results of Horizontal-Intensity Comparisons at the Kew Observatory, 1919.*

Date	Local mean time		Hor. int. obtained[1]		I. M. S.—Kew	Remarks
	From	To	I. M. S.	Kew		
1919	*h m*	*h m*	γ	γ	γ	
April 2	11 41	12 33	18367	18395	−28[2]	C. I. W. magnetometer No. 13 at N_m; Kew data are from magnetograms based on Kew Jones magnetometer observations at O_m.
2	15 53	16 36	408	428	−20	
2	17 03	17 45				
3	8 36	9 20	383	407	−24	
3	10 08	10 50				
3	12 03	12 44	398	410	−12	
3	16 01	16 44				
Mean value of (I. M. S.—Kew)					−20.0γ or −0.00109H	

[1] It is assumed that any station-difference between piers N_m and O_m is negligible.
[2] Half set; weight 0.5.

TABLE 10F.—*Results of Inclination Comparisons at the Kew Observatory, 1919.*

Date	Local mean time		Inclination obtained[1]		I. M. S.—Kew	Remarks
	From	To	I. M. S.	Kew		
1919	*h m*	*h m*	° ′	° ′	′	
April 2	13 24	14 07	+66 57.0	+66 58.4	−1.4	C. I. W. circle No. 177 at N_e; Kew Barrow circle at N_w.
2	14 23	15 05	57.8	57.2	+0.6	
3	13 10	13 56	57.0	57.7	−0.7	
3	14 21	15 08	56.6	57.4	−0.8	C. I. W. circle at N_w; Kew Barrow circle at N_e.
4	13 11	13 57	59.0	59.8	−0.8	
4	14 11	14 56	58.2	59.3	−1.1	
Mean value of (I. M. S.—Kew)					−0.7	

[1] It is assumed that any station-difference between piers N_e and N_w is negligible.

SUMMARY.

Table 10 G summarizes the chief results as already published in Volume II[a] and as given above.

There is indication of a change in the standard at Kew in horizontal intensity which may possibly arise from further change with time in the moment of inertia of the magnet used in oscillations. It should be noted, however, in this connection that the value (10*c*) is tentative pending restandardization of C.I.W. magnetometer No. 13 upon its return from field use.

[a] See *Res. Dep. Terr. Mag.*, Vol. II, pp. 240–243.

TABLE 10G.—*Summary of Corrections on Standards for Kew Observatory.*

Date	(I. M. S.—Kew)					
	Declination	Weight	Hor. Int.	Weight	Inclination	Weight
	′				′	
1902–1915...	......	...	....	...	−1.1[1]	2.0
1908, Mar....	+0.47	1.0	−0.00008H	1.0	−2.2	1.0
1910, Mar....	+0.66	1.0	−0.00008H	1.0	−0.3	1.0
1914, Oct.... Nov. .. 1915, Feb., Mar., Nov.	......	...	−0.00043H[2]	0.5	......	...
1915, Aug...	+0.08	1.0	−0.00050H	1.0	−0.15	1.0
1915, Oct....	−0.16	1.0	−0.00040H	0.5	−0.07	1.0
1919, Apr....	+0.34	1.0	−0.00109H[3]	...	−0.7	1.0

[1] Compilation of comparisons of 16 dip circles at Kew, 1902–1915.
[2] Indirect comparison obtained through magnetometer C. & G. S. No. 40 at Kew and at Cheltenham.
[3] Value adopted tentatively pending redetermination of constants and correction of C. I. W. instrument (see p. 439).

Whence we obtain weighted mean values as follows:

(10) I. M. S.—Kew (Jones magnetometer) = +0′.3 (1908–1919).
(10*a*) I. M. S.—Kew (Jones magnetometer) = −0.00008H (1908–1910).
(10*b*) I. M. S.—Kew (Jones magnetometer) = −0.00046H (1914–1915).
(10*c*) I. M. S.—Kew (Jones magnetometer) = −0.00109H (1919).
(10*d*) I. M. S.—Kew (Barrow dip circle No. 33, needles 1, 2) = −0′.8 (1902–1919).

NO. 11.—LOANDA OBSERVATORY, ANGOLA.

During March 10 to 12, 1920, comparisons were secured by Observer F. Brown at the Loanda (João Capello) Observatory in the upper city of Loanda. Because of the scant time available comparisons were made only for declination and inclination. There being no available space within the Observatory grounds suitable for a secondary station, the work was done on the single large pier (section 45 cm. by 90 cm.) of the absolute house. Declination observations were made with C. I. W. magnetometer on small raised platform, designated B, near center of pier about 25 cm. north of point, designated C, on the pier over which the Observatory magnetometer is mounted for the determination of declination and horizontal intensity. Inclination observations with both C. I. W. and Observatory instruments were made on north end of the pier at a point designated A; this is the station regularly used by the Observatory for inclination determinations. The Observatory mark, west corner of Fort Miguel, was used, its bearing as supplied by Commandant Rebelho, Acting Director of the Observatory, being from C and from B 175° 51′.0 west of south.

The Observatory instruments used were Elliott magnetometer No. 200 and dip circle No. 115 (needle No. 1), both by Negretti and Zambra. The dip circle is an old instrument, and needle No. 1 has been in use for 20 years and is somewhat corroded. The C. I. W. instruments were magnetometer No. 13 and dip circle No. 177 with needles 13X and 14X. Throughout, the method of comparison by alternate observations was followed. The observations reported upon were all made by Mr. Brown, who followed with the Observatory instruments the Observatory procedure as instructed by Commandant Rebelho. The I. M. S. values given depend upon the corrections finally adopted for C. I. W. magnetometer No. 13 and dip circle No. 177.

TABLE 11A.—*Results of Declination Comparisons at the Loanda Observatory, 1920.*

Date	Local mean time		Declination obtained[1]		I. M. S.—Loanda	Station	
	From	To	I. M. S.	Loanda		C. I. W.	Loanda
1920	h m	h m	° ′	° ′	′		
Mar. 11	8 35	8 42	−14 43.6	−14		*B*	....
11	8 52	8 59	....	44.6	+1.8	....	*C*
11	9 06	9 12	....	44.6		....	*C*
11	9 21	9 28	42.0	....		*B*	....
11	9 37	9 44	41.4	....		*B*	....
11	9 50	9 55	....	43.5		....	*C*
11	10 02	10 06	....	42.3	+2.3	....	*C*
11	10 14	10 21	39.8	....		*B*	....
11	10 29	10 36	39.2	....		*B*	....
11	10 42	10 48	....	40.6		....	*C*
11	10 53	10 57	....	41.5	+2.4	....	*C*
11	11 03	11 10	38.0	....		*B*	....
Mean value of (I. M. S.—Loanda)...............					+2.2		

[1] It is assumed that there is no station-difference between stations *B* and *C*.

TABLE 11B.—*Results of Inclination Comparisons at the Loanda Observatory, 1920.*

Date	Local mean time		Inclination obtained		I. M. S.—Loanda	Station	
	From	To	I. M. S.	Loanda		C. I. W.	Loanda
1920	h m	h m	° ′	° ′	′		
Mar. 11	13 56	14 25	−37 23.1	−37		*A*	....
11	14 44	15 22	....	26.1	+3.7	....	*A*
11	16 00	16 25	....	26.7		....	*A*
11	16 48	17 18	22.3	....		*A*	....
12	7 11	7 43	24.0	....		*A*	....
12	7 57	8 18	....	28.2	+5.4	....	*A*
12	8 27	8 47	....	26.8		....	*A*
12	9 02	9 33	20.2	....		*A*	....
Mean value of (I. M. S.—Loanda)..............					+4.6		

From the above we have:

(11) I. M. S. − Loanda (Elliott magnetometer No. 200) = +2′.2 (1920).
(11*a*) I. M. S. − Loanda (Dip circle No. 115, needle 1) = +4′.6 (1920).

NO. 12.—LUKIAPANG OBSERVATORY, CHINA.

The comparisons during October 31 to November 3, 1917, at the Lukiapang Observatory were obtained by Observer F. Brown upon the conclusion of his expedition in the provinces of southeast China. The stations used for the comparisons of 1911 were reoccupied. The stations for *D* and *H* observations were the "Elliott Pillar" (D_a) in the absolute house (*D*), and "Edmunds Pillar" (*F*) in the grounds about 18 meters southwest of D_a. The same mark was used at both stations, viz, an arrangement of black and white triangles painted on bronze sheet on granite slab in the south wall of the compound; the azimuth of this mark as supplied by Reverend J. de Moidrey, Director of the Magnetic Observatory, from station D_a is 3° 47′.1 west of south (previous to 1915 the value 3° 47′.0 was used, but further determinations have yielded the above value which is now used), and from station *F* 357° 08′.4 west of south. As in the comparisons of 1911 it was not possible to move the Observatory earth-inductor so as to afford an exchange of stations and the C.I.W. dip-circle was mounted on the pillar *b*, designated D_b, one meter north of pillar *c*, designated D_c, on which the Observatory earth-inductor No. 42 is mounted.

The Observatory instruments used in these comparisons were the same as used in the comparisons of 1911, viz, Elliott magnetometer No. 49 and Schulze earth inductor No. 42. Unfortunately owing to a mishap on August 20, 1917, with the magnet used for the declination observations it had been found necessary to remagnetize it not long before the comparisons; thus the values obtained for the differences of magnetometer No. 49 on International Magnetic Standards are not comparable with former values. The C.I.W. instruments were magnetometer No. 9 and dip circle No. 206 with needles 1 and 2 of 206 and needles 5 and 6 of 178. The comparisons for D and H were obtained by the method of simultaneous observations and exchange of stations. The observations for the inclination comparisons were made with No. 42 and No. 206 alternately, the dip needles being removed during observations with No. 42 and the coils of the latter being kept stationary while No. 206 was in use. A complete inclination intercomparison consisted of: (1) Observations with the earth inductor according to usual method of the Observatory; (2) inclination with one pair of needles of No. 206, ends "A" or "B" down; (3) earth inductor same as (1); (4) inclination with second pair of needles of No. 206, ends "A" or "B" down; (5) earth inductor same as (1); (6) second half of inclination with second pair of needles of No. 206, ends "B" or "A" down; (7) earth inductor same as (1); (8) second half of inclination with first pair of needles of No. 206, ends "B" or "A" down; (9) earth inductor same as (1). Thus the mean of earth-inductor observations (1), (3), (5), (7), and (9) corresponded with the mean of the dip-circle observations (2), (4), (6), and (8). Any station-difference between D_b and D_c had to be considered as negligible. The Observatory observations were made under the direction of Reverend de Moidrey by Mr. Zi with the assistance in earth-inductor work of Mr. Lee, both of Observatory staff; the C.I.W. observations were all made by Mr. Brown.

The I.M.S. values depend upon the corrections finally adopted for C.I.W. magnetometer No. 9 and dip circle No. 206. It is to be noted that both needles 5 and 6 of circle 178 were somewhat erratic in behavior for inclinations between +45° and +46°; two values with needle 6 had therefore to be omitted from the tabulation of results.

Except for November 3, there was steady rain during the comparisons and the weather was extremely dull and gloomy. This fact may account partly for the apparently erratic values obtained for D with magnetometer No. 49 since a silk fiber was used for suspension. For this reason Reverend de Moidrey has also supplied the magnetogram scalings for declination which depend on base-line determinations made prior to the accident of August 20, 1917, and these are incorporated in the tabulation of results; as will be noted, the value thus derived for (I.M.S.—Lukiapang) = $-1'.3$ is substantially in agreement with the value obtained in 1911, viz, $-1'.5$, while the value derived from the magnetometer comparisons is $+0'.8$, indicating that the accident caused a substantial change in the declination correction of magnetometer No. 49. The result obtained from the inclination comparisons is identical with that obtained in 1911.

The horizontal-intensity comparisons show a decided change in value of (I. M. S.—Lukiapang) since the comparisons of 1911 which may arise in part from the accident above referred to. When transmitting the values of H for the Observatory Reverend de Moidrey made the following notes:

"It was at first supposed that the distribution coefficient had not been much affected by the accident of August 20 but this did not prove to be correct. We therefore took for P the mean of 43 determinations made during the period September 11 to December 5, 1917, which gave for H the values herewith sent you, but these values differ considerably from those of Mr. Brown. We also compared each series with the magnetograph at 18° and determined base-line values as follows: For Mr. Brown 33141.7γ with a mean error 9.3γ, and for Mr. Zi 33083.8γ with a mean error of 9.2γ. These values therefore amount practically to equal precision, but I am at a loss to explain the great

difference; it must be instrumental. . . . . From 1911 to 1917 neither the piers nor the surroundings have been changed in any way. We have, moreover, computed the provisional diurnal means for all the days of absolute observations of 1917. The seven first months are extremely even, that is, up to the time of the accident. In September we find again precisely the previous value; afterwards H increases a little. By applying to the first months the reduction on I. M. S. and to the following months a correction which accords with the instruments of Mr. Brown, when reduced to I. M. S., our last three months show a perceptible increase but not an unreasonable one."

Thus it appears that at least some part of the change indicated by the present comparisons is caused by change in constants arising from the accident. It is interesting to note however also the gradual increase in the value of the correction on I. M. S. as successively determined in 1907, 1911, and 1917.

TABLE 12A.—*Results of Declination Comparisons at the Lukiapang Observatory, 1917.*

Date	Local mean time		Declination obtained[1]			I. M. S.—Lukiapang		Remarks
	From	To	I. M. S.	Lukiapang No. 49	Lukiapang Magnetogr.	No. 49	Magnetogr.	
1917	h m	h m	° ′	° ′	° ′	′	′	
Oct. 31	13 28	13 35	−3 19.5	−3 14.4	−3 18.4	?	−1.1	C. I. W. No. 9 at F; Lukiapang No. 49 at D_a; magnetograph data based on observations at D_a.
31	15 13	15 20	19.2	14.8	18.1	?	−1.1	
Nov. 1	8 56	9 03	15.1	12.0	13.5	?	−1.6	
1	14 16	14 23	19.7	20.0	18.4	+0.3	−1.3	
1	14 44	14 49	20.0	19.9	18.6	−0.1	−1.4	
1	14 59	15 06	19.6	19.6	18.2	0.0	−1.4	
2	9 12	9 20	14.0	13.7	13.1	−0.3	−0.9	
2	10 52	10 59	16.7	16.5	15.5	−0.2	−1.2	
2	11 25	11 33	18.8	18.8	17.6	0.0	−1.2	
2	11 38	11 45	19.1	19.7	18.3	+0.6	−0.8	
2	13 25	13 33	21.7	22.8	19.9	+1.1	−1.8	C. I. W. No. 9 at D_a; Lukiapang No. 49 at F; magnetograph data based on observations at D_a.
2	15 14	15 22	20.0	20.8	18.4	+0.8	−1.6	
2	15 35	15 43	19.5	20.6	17.9	+1.1	−1.6	
3	8 12	8 20	15.4	17.6	14.1	+2.2	−1.3	
3	8 28	8 36	15.3	16.9	13.8	+1.6	−1.5	
3	9 00	9 08	14.9	15.2	13.5	+0.3	−1.4	
3	11 00	11 10	16.8	18.9	15.7	+2.1	−1.1	
3	13 06	13 14	19.7	21.7	18.3	+2.0	−1.4	
3	13 27	13 36	20.1	22.1	18.6	+2.0	−1.5	
Mean value of [I. M. S.—Lukiapang (magnetometer No. 49)]						+0.8		
Mean value of [I. M. S.—Lukiapang (magnetograph)].......						.....	−1.3	

[1] All values by magnetometers No. 9 and No. 49 are referred to D_a; $D_a=F-1'.0$ the weighted mean value from the following determinations: September 1911, $-1'.1$ (referred to new azimuth of mark at D_a), weight 1; November 1917 by magnetometer data as above, $-0'.3$, weight 1; and October to November 1917 by magnetometer No. 9 and magnetograph scalings as above, $-1'.3$, weight 2.

TABLE 12B.—*Results of Horizontal-Intensity Comparisons at the Lukiapang Observatory, 1917.*

Date	Local mean time		Hor. int. obtained[1]		I. M. S.—Lukiapang	Remarks
	From	To	I. M. S.	Lukiapang		
1917	h m	h m	γ	γ	γ	
Oct. 31	13 45	15 11	33204	33156	+48	C. I. W. magnetometer No. 9 at F; Lukiapang magnetometer No. 49 at D_a.
Nov. 1	9 13	9 56	226	168	+58	
1	13 30	14 08				
2	9 28	10 48	222	156	+66	
2	13 41	15 04	229	170	+59	C. I. W. magnetometer No. 9 at D_a; Lukiapang magnetometer No. 49 at F.
2	15 51	17 11	236	168	+68	
3	9 27	10 51	246	203	+43	
3	11 26	12 04	270	202	+68[2]	
Mean value of (I. M. S.—Lukiapang)..........					+57.9γ or +0.00175H	

[1] All values are referred to D_a; $D_a=F-2.8\gamma$. [2] Half set; weight 0.5.

TABLE 12C.—*Results of Inclination Comparisons at the Lukiapang Observatory, 1917.*

Date	Local mean time		Inclination obtained[1]		I. M. S.—Lukiapang	Remarks
	From	To	I. M. S.	Lukiapang		
1917	h m	h m	° ′	° ′	′	
Oct. 31	8 01	9 30	+45 33.1[2]	+45 32.3	+0.8	C. I. W. dip circle No. 206 at D_b; Lukiapang earth inductor No. 42 at D_c.
31	10 17	11 34	30.0[2]	31.3	−1.3	
31	15 56	17 13	32.2	32.6	−0.4	
Nov. 1	15 39	16 53	33.3	32.4	+0.9	
Mean value of (I. M. S.—Lukiapang)............					0.0	

[1] It is assumed that any station-difference between piers D_b and D_c is negligible.
[2] Results by needle 6 of circle 178, viz, +45° 35′.5 and +45° 35′.1, rejected in means because of erratic behavior.

SUMMARY.

Table 12D summarizes the chief results as already published in Volume II[a] and as given above.

TABLE 12D.—*Summary of Corrections on Standards for Zikawei and Lukiapang Observatories.*

Date	(I. M. S.—Lukiapang)					
	Declination	Weight	Hor. int.	Weight	Inclination	Weight
	′				′	
May 1907[1]...	−1.1	0.5	+0.00074H	0.5	−0.4[2]	1.0
Sep. 1907[1]...	−1.1	0.5	+0.00049H	1.0	......	...
Sep. 1911...	−1.5	1.0	+0.00084H	1.0	0.0	1.0
Oct.–Nov. 1917......	−1.3[3]	1.0	+0.00175H[4]	1.0	0.0	1.0

[1] Results obtained at Zikawei Observatory.
[2] Standard in inclination in 1907 was Dover dip circle No. 33, needle 14; Schulze earth inductor No. 42 was standard for subsequent work.
[3] Value as derived from magnetograph scalings based on absolute observations with Observatory standard Elliott magnetometer No. 49 before accident to latter.
[4] Instrumental change account of accident on August 20, 1917.

Hence, we obtain weighted mean values as follows:

(12) I. M. S.—Lukiapang-Zikawei (Elliott magnetometer No. 49) = −1′.3 (1907–1917).
(12*a*) I. M. S.—Lukiapang-Zikawei (Elliott magnetometer No. 49) = +0.00068H (1907–Aug. 1917).
(12*b*) I. M. S.—Zikawei (Dover dip circle No. 33, needle 14) = −0′.4 (1907).
(12*c*) I. M. S.—Lukiapang (Schulze earth inductor No. 42) = 0′.0 (1911–1917).
(12*d*) I. M. S.—Lukiapang (Elliott magnetometer No. 49) = +0.00175H (Oct.–Nov. 1917).

NO. 13.—PILAR OBSERVATORY, ARGENTINA.

During the stay of the *Carnegie* in Buenos Aires in 1917, two series of comparisons were obtained at the Pilar Observatory of the Meteorological Office of Argentina, the first during March and April and the second during November. The Meteorological Office of Argentina is under the direction of Mr. George O. Wiggin. The first series consisted of absolute observations with interchange of stations at the wooden observatories *B* and *D*, the former being the same station as that occupied in the comparisons of 1913,[b] while *D* is the new wooden absolute observatory erected since the comparisons of 1913. The observatory *D* takes the place of the combined office and absolute observatory which was in use during the visit of the *Carnegie* in 1911; two piers in observatory *D* are regularly used in the Observatory work for the control of the variometers. Pier

[a] See *Res. Dep. Terr. Mag.*, Vol. II, pp. 264–267. [b] See *Res. Dep. Terr. Mag.*, Vol. II, pp. 245–247.

5, designated *D*5, is used for declination and intensity, and pier 4, designated *D*4, is used for inclination. For the work in November, absolute observations were made with the C.I.W. instruments at the stations *D*4, and *D*5, the Observatory values being deduced from the magnetograph data. The Observatory azimuth mark, the central of three vertical lines on a stone pier near the tennis court, was used; its azimuth from station *B* is 100° 14′.4 west of true south, and from station *D*5, 94° 36′.1 west of true south, these values being supplied by Prof. F. H. Bigelow who is in immediate charge of the work at Pilar. The Pilar results were obtained by Observers O. Lützow-Holm and Blüthgen of the Observatory staff. The C.I.W. observations during March and April were made by Observers H.M.W. Edmonds and A. D. Power, and during November by Observer A. D. Power.

The Observatory instruments used in the comparisons of March and April were Dover-Kew magnetometer No. 175 and Toepfer earth inductor No. 3; these are the standard instruments of the Observatory, and are used regularly for the control of the magnetograph data upon which the series of comparisons during November depend. The C.I.W. instruments used were magnetometer No. 5 for declination in April, and magnetometer-inductor No. 25 for declination in November and for horizontal intensity and inclination during both series. The I.M.S. values given depend upon the constants and corrections finally adopted for the C.I.W. instruments.

TABLE 13A.—*Results of Declination Comparisons at the Pilar Observatory, 1917.*

Series	Date	Local mean time		Declination obtained[1]		I. M. S.—Pilar	Remarks
		From	To	I. M. S.	Pilar		
	1917	h m	h m	° ′	° ′	′	
I	April 3	14 21	14 30	+8 16.5	+8 17.5	−1.0	C. I. W. magnetometer No. 5 at *B*; Pilar magnetometer No. 175 at *D*5.
	3	14 35	14 44	16.5	17.3	−0.8	
	3	15 18	15 27	16.9	16.3	+0.6	
	3	15 32	15 41	16.4	16.0	+0.4	
	3	16 12	16 21	14.9	17.0	−2.1	
	3	16 26	16 35	15.1	17.0	−1.9	
	4	8 58	9 08	10.7	11.2	−0.5	C. I. W. magnetometer No. 5 at *D*5; Pilar magnetometer No. 175 at *B*.
	4	9 12	9 22	10.8	11.4	−0.6	
	4	9 52	10 02	12.0	12.5	−0.5	
	4	10 06	10 16	12.2	12.9	−0.7	
	4	11 20	11 30	14.9	15.7	−0.8	
	4	11 34	11 44	15.5	16.7	−1.2	
Mean value of (I. M. S.—Pilar)						−0.76	
	1917						
II	Nov. 9	10 29	10 38	+8 11.4	+8 13.1	−1.7	C. I. W. magnetometer No. 25 at *D*5 throughout; Pilar values are from magnetograph data controlled by observations with magnetometer No. 175 at *D*5.
	9	10 51	11 00	12.1	13.8	−1.7	
	9	11 21	11 30	13.5	14.1	−0.6	
	9	13 29	13 38	12.7	14.2	−1.5	
	9	15 05	15 14	11.1	11.6	−0.5	
	9	17 08	17 17	07.9	08.7	−0.8	
	12	8 07	8 16	05.4	07.1	−1.7	
	12	10 11	10 20	10.1	11.2	−1.1	
	12	10 33	10 42	11.4	12.7	−1.3	
	12	12 45	12 54	16.0	16.4	−0.4	
	12	14 19	14 28	14.4	14.7	−0.3	
	12	16 13	16 22	09.9	11.1	−1.2	
Mean value of (I. M. S.—Pilar)						−1.07	
Mean value of (I. M. S.—Pilar) from I and II						−0.9	

[1] The values on April 3 and 4 are all referred to *D*5; *D*5 = *B* − 0′.5.

TABLE 13B.—*Results of Horizontal-Intensity Comparisons at the Pilar Observatory, 1917.*

Series	Date	Local mean time		Hor. int. obtained[1]		I. M. S.—Pilar	Remarks
		From	To	I. M. S.	Pilar		
	1917	h m	h m	γ	γ	γ	
I	Mar. 19	9 03	11 00	25478	25488	−10	C. I. W. magnetometer No. 25 at *B*; Pilar magnetometer No. 175 at *D5*.
	19	13 53	15 33	480	492	−12	
	20	9 05	11 18	489	506	−17	
	20	14 20	16 19	486	498	−12	C. I. W. magnetometer No. 25 at *D5*; Pilar magnetometer No. 175 at *B*.
	21	9 01	11 29	471	480	− 9	
	21	14 04	15 59	460	478	−18	
Mean value of (I. M. S.—Pilar)						−13.0γ or −0.00051*H*	
	1917						
II	Nov. 9	8 29	10 25	25478	25478	0	C. I. W. magnetometer No. 25 at *D5* throughout; Pilar values are from magnetograph data controlled by observations with magnetometer No. 175 at *D5*.
	9	11 35	13 27	497	508	−11	
	9	15 17	17 06	472	479	− 7	
	12	8 22	10 08	460	469	− 9	
	12	10 45	12 43	437	445	− 8	
	12	14 30	16 11	393	394	− 1	
Mean value of (I. M. S.—Pilar)						− 6.0γ or −0.00024*H*	
Mean value of (I. M. S.—Pilar) from I and II						− 9.5γ or −0.00037*H*	

[1] The values on March 19, 20, 21, are all referred to *D5*; $D5 = B + 4.2\gamma$.

TABLE 13C.—*Results of Inclination Comparisons at the Pilar Observatory, 1917.*

Series	Date	Local mean time		Inclination obtained[1]		I. M. S.—Pilar	Remarks
		From	To	I. M. S.	Pilar		
	1917	h m	h m	° ′	° ′	′	
I	Mar. 26	10 01	10 55	−25 36.4	−25 36.9	+0.5	C. I. W. inductor No. 25 at *B*; Pilar inductor No. 3 at *D4*.
	26	11 09	11 45	35.9	35.5	−0.4	
	27	8 38	9 12	41.9	41.4	−0.5	
	27	10 24	10 56	37.5	37.3	−0.2	C. I. W. inductor No. 25 at *D4*; Pilar inductor No. 3 at *B*.
	27	11 14	11 46	37.7	37.5	−0.2	
	27	12 06	12 38	37.1	37.2	+0.1	
Mean value of (I. M. S.—Pilar)						−0.12	
	1917						
II	Nov. 10	8 23	8 54	−25 38.5	−25 38.3	−0.2	C. I. W. inductor No. 25 at *D4* throughout; Pilar values are deduced from magnetograph data for horizontal and vertical intensity controlled by observations with inductor No. 3 at *D4* and magnetometer No. 175 at *D5*.
	10	9 17	9 42	35.8	35.7	−0.1	
	10	10 02	10 30	35.2	35.2	0.0	
	13	9 22	9 55	36.8	37.0	+0.2	
	13	10 18	10 48	37.0	36.4	−0.6	
	13	11 13	11 38	37.1	36.8	−0.3	
Mean value of (I. M. S.—Pilar)						−0.18	
Mean value of (I. M. S.—Pilar) from I and II						−0.1	

[1] The values on March 26 and 27 are all referred to *D4*; $D4 = B + 0'.5$.

SUMMARY.

Table 13D summarizes the chief results as already published in Volume II[a] and as given above.

[a] See *Res. Dep. Terr. Mag.*, Vol. II, pp. 245–247.

TABLE 13D.—*Summary of Corrections on Standard for Pilar Observatory.*

Date	(I. M. S.—Pilar)					
	Declination	Weight	Hor. int.	Weight	Inclination	Weight
	′				′	
Jan. 1911[1]........	+0.4	1.0	−0.00101H	1.0	+0.3	1.0
Jun. 1913........	−0.13	1.5	−0.00028H	1.5	......	...
Apr. 1917........	−0.76	1.0	−0.00051H	1.0	−0.12	1.0
Nov. 1917........	−1.07	1.0	−0.00024H	1.0	−0.18	1.0

[1] Pilar standards in 1911 were Dover magnetometer No. 138 and mean of dip circle No. 216 and Toepfer inductor No. 3, and not Dover magnetometer No. 175 and Toepfer inductor No. 3 as in 1913 to 1917.

Hence we obtain weighted mean values as follows:

(13) I. M. S.—Pilar (Dover magnetometer No. 138) = +0′.4 (1911).
(13*a*) I. M. S.—Pilar (Dover magnometer No. 138) = −0.00101H (1911).
(13*b*) I. M. S.—Pilar (Dip circle No. 216 and inductor No. 3) = +0′.3 (1911).
(13*c*) I. M. S.—Pilar (Dover magnetometer No. 175) = −0′.6 (1913–1917).
(13*d*) I. M. S.—Pilar (Dover magnetometer No. 175) = −0.00033H (1913–1917).
(13*e*) I. M. S.—Pilar (Toepfer inductor No. 3) = −0′.1 (1917).

NO. 14.—RIO DE JANEIRO OBSERVATORY AT VASSOURAS, BRAZIL.

The comparisons of 1915 were obtained by Observer D. W. Berky, and those of 1919 by Observer A. Sterling. The stations used for the comparisons of 1913,[a] the concrete piers *A* and *B* in the non-magnetic house for absolute observations at Vassouras, were reoccupied, and for the inclination work in 1919 the pier *C* was also used; pier *A* is 3.3 meters east 5°.2 of true north of pier *B*, and pier *C* is 3.3 meters south-southeast of pier *A*. As it was thought there might possibly be, because of the short distances between piers, a disturbing effect of one instrument on the second instrument, special tests were made during the work in 1919; these tests showed there were no sensible disturbing effects. At *A* the center of pin on the Observatory azimuth mark was used, the azimuth as supplied by Dr. Morize, Director of the Observatory, being 146° 40′.7 west of true south. At *B* the azimuth mark in 1915 was the left edge of a white house on a hill about one mile (1.6 kilometers) distant, its azimuth as supplied by Dr. Morize being 174° 55′.9 west of true south; in 1919 the near corner of a house about one mile (1.6 kilometers) distant was used, its azimuth as determined by Observer Sterling's angular measurements to the Observatory mark being 175° 16′.2 west of true south. The Observatory determinations of 1915 were made by Dr. A. C. Lemos, now chief of the Section of Terrestrial Physics, and those of 1919 by Observer G. M. Soares.

The Observatory instruments used in the comparisons were magnetometer No. 25 by Cooke and Son in 1915 and 1919, dip circle No. 8075 with needles 1 and 2 in 1915, and dip circle No. 221 with needles 1 and 2 and needle 2 of 8075 in 1919. It should be noted that these are not the same instruments as those used by the Observatory for the comparisons of 1913.[1] The C. I. W. instrument used in 1915 was universal magnetometer No. 19 with dip needles 1 and 2 of C. I. W. magnetometer No. 21, and in 1919 magnetometer No. 16 and dip circle No. 242 with needles 1, 2, 5, and 6. Dip observations were also made in 1915 by Mr. Berky, using needles 2 and 6 of magnetometer 19, but the results by those needles had to be rejected because of development of rust on pivots.

The I. M. S. values given depend upon the constants finally adopted for the C. I. W. instruments. When magnetometer 19 was returned from the field in September 1915, it was found that there had been an appreciable decrease in the moment of inertia for magnet 19*L* and its suspension. Examination of the comparisons with standards for

[a] See *Res. Dep. Terr. Mag.*, Vol. II, pp. 253-254.

magnetometer 19 showed that the decrease had taken place practically as a linear function of the time during which the instrument was in field service.

The absolute declination-observations on September 25, 1919, were erratic for some reason, and the values for Rio de Janeiro in the declination-series of 1919 are, therefore, based upon magnetograph scalings, using the observations of September 24 only. The base-line value finally adopted and communicated by Dr. Morize in his letter of February 23, 1921, viz, 11° 58′.8, as determined by absolute observations with magnetometer No. 25 at station *A*, was used.

The horizontal-intensity results for the Observatory depend upon values of the distribution coefficient, P', derived from the comparison observations only. The Observatory values for horizontal intensity given in Table 14B may, therefore, be considered as provisional. Had the value of P' used for the reductions of the 1919 work at Vassouras with magnetometer 25 been used in computing the results for 1915, the resulting value of (I. M. S.—Rio de Janeiro) would have been $-0.00292H$ instead of $-0.0032H$. Dr. Morize states that, as a result of intercomparisons made on November 22, 1916, at Vassouras between Observatory magnetometer Cooke No. 25 and Cooke No. 18, the value obtained for (Rio de Janeiro 25—Rio de Janeiro 18) = $+20\gamma$ or $+0.00081H$. Accepting from Table 14B the mean value (I. M. S.—Rio de Janeiro 25) = $-0.0034H$, we have (I. M. S.—Rio de Janeiro 18) = $-0.0026H$.

Because of the erratic behavior of needles in dip circle 221 during the comparisons of 1919, it was necessary to deduce from the horizontal-intensity and vertical-intensity magnetograms a base-line value for inclination depending upon the mean of the six observations made with the three needles at piers *C* and *A* with circle 221 on September 26 and 27. The mean temperatures in the magnetograph room for the intervals covered during the inclination observations were the same for the first three and the last three sets; the variation in inclination, ΔI expressed in minutes of arc, was determined by the formula (ΔZ and ΔH being in gammas):

$$\Delta I = 0.131\ \Delta Z + 0.035\ \Delta H$$

TABLE 14A.—*Results of Declination Comparisons at the Rio de Janeiro (Vassouras) Observatory, 1915 and 1919.*

Series	Date	Local mean time: From	Local mean time: To	Declination obtained[1]: I. M. S.	Declination obtained[1]: Rio de Janeiro	I. M. S.—Rio de Janeiro	Remarks
	1915	*h m*	*h m*	° ′	° ′	′	
I	Mar. 26	15 38	15 47	−10 26.4	−10 26.2	−0.2	C. I. W. magnetometer No. 19 at *B*; Rio de Janeiro magnetometer No. 25 at *A*.
	26	16 35	16 44	27.5	26.9	−0.6	
	28	10 33	10 42	28.3	27.4	−0.9	
	28	17 04	17 13	27.6	25.6	−2.0	
	29	7 58	8 07	28.6	28.4	−0.2	
	29	10 51	11 00	25.2	24.5	−0.7	
	29	13 49	13 58	22.8	21.7	−1.1	C. I. W. magnetometer No. 19 at *A*; Rio de Janeiro magnetometer No. 25 at *B*.
	29	16 54	17 03	27.9	26.1	−1.8	
	30	8 37	8 46	31.4	30.2	−1.3	
	30	11 02	11 11	27.6	27.0	−0.6	
	30	13 57	14 06	25.1	25.4	+0.3	
	30	16 21	16 30	28.0	27.3	−0.7	
Mean value of (I. M. S.—Rio de Janeiro)...............						−0.8	(weight, 1.0)
	1919						
II	Sep. 24	9 29	9 38	−11 11.9	−11 13.5	+1.6	C. I. W. magnetometer No. 16 at *A*; Rio de Janeiro values from magnetogram.
	24	12 38	12 45	06.6	08.2	+1.6	
	24	12 56	13 05	08.2	10.0	+1.8	
	24	14 49	14 58	12.4	13.7	+1.3	
	24	15 10	15 19	12.5	14.6	+2.1	
	24	17 00	17 09	12.8	14.7	+1.9	
Mean value of (I. M. S.—Rio de Janeiro)...............						+1.7	(weight, 0.5)
Weighted mean value of (I. M. S.—Rio de Janeiro) from I and II....................................						+0.0	

[1] All values are referred to station *A*; in 1915, $A = B + 0'.1$.

TABLE 14B.—*Results of Horizontal-Intensity Comparisons at the Rio de Janeiro (Vassouras) Observatory, 1915 and 1919.*

Series	Date	Local mean time[1]		Hor. int. obtained[2]		I. M. S.—Rio de Janeiro	Remarks
		From	To	I. M. S.	Rio de Janeiro		
	1915	h m	h m	γ	γ	γ	
I	Mar. 27	9 59	11 47	24603	24669	−66	C. I. W. magnetometer No. 19 at *B*; Rio de Janeiro magnetometer No. 25 at *A*.
	27	14 06	15 21				
	27	16 18	17 22	562	652	−90	
	28	7 57	8 42				
	29	8 13	10 33	604	684	−80	
	29	14 01	16 37	580	663	−83	C. I. W. magnetometer No. 19 at *A*; Rio de Janeiro magnetometer No. 25 at *B*.
	30	8 49	10 45	600	671	−71	
	30	14 09	16 15	567	648	−81	
Mean value of (I. M. S.—Rio de Janeiro)...............						−78.5γ or −0.0032*H*	
	1919						
II	Sep. 24	9 49	11 42	24519	24601	− 82	C. I. W. magnetometer No. 16 at *A*; Rio de Janeiro magnetometer No. 25 at *B*.
	24	13 10	14 44	449	530	− 81	
	24	15 26	16 57	381	480	− 99	
	25	8 46	10 46	460	564	−104	C. I. W. magnetometer No. 16 at *B*; Rio de Janeiro magnetometer No. 25 at *A*.
	25	13 15	14 46	459	537	− 78	
	25	15 32	17 00	418	497	− 79	
Mean value of (I. M. S.—Rio de Janeiro)...............						− 87.2γ or −0.00355*H*	
Mean value of (I. M. S.—Rio de Janeiro) from I and II...						− 82.8γ or −0.0034*H*	

[1] The times given apply for the C. I. W. observations; the Rio de Janeiro observations were not strictly simultaneous, but the intervals between the mean times for the corresponding sets are not great enough to affect materially the values of (I. M. S.—Rio de Janeiro) since the diurnal variation in horizontal intensity is small.

[2] All values are referred to station *A* by the value of station-difference determined from each series; in 1915, $A=B-5.7\gamma$, and in 1919, $A=B-6.6\gamma$.

TABLE 14C.—*Results of Inclination Comparisons at the Rio de Janeiro (Vassouras) Observatory, 1915 and 1919.*

Series	Date	Local mean time		Inclination obtained[1]		I. M. S.—Rio de Janeiro	Remarks
		From	To	I. M. S.	Rio de Janeiro		
	1915	h m	h m	° ′	° ′	′	
I	Mar. 31	8 07	10 04	−14 40.4	−14 40.0	−0.4	C. I. W. magnetometer No. 19 at *A*; Rio de Janeiro dip circle No. 8075 at *B*.
	31	10 32	12 06	39.0	39.8	+0.8	
	31	14 23	15 46	43.4	40.8	−2.6	
	31	16 02	17 22	43.0	42.0	−1.0	C. I. W. magnetometer No. 19 at *B*; Rio de Janeiro dip circle No. 8075 at *A*.
	Apr. 1	7 41	9 02	41.5	40.6	−0.9	
	1	9 14	10 26	38.8	38.6	−0.2	
Mean value of (I. M. S.—Rio de Janeiro 8075)...........						−0.7	
	1919						
II	Sep. 26	9 59	11 22	−15 12.1	−15 11.4	−0.7	C. I. W. dip circle No. 242 at *A*; Rio de Janeiro dip circle No. 221 at *C*.[2]
	26	13 26	14 52	16.7	16.5	−0.2	
	26	15 08	16 26	18.8	17.6	−1.2	
	27	9 00	10 23	11.0	10.6	−0.4	C. I. W. dip circle No. 242 at *C*; Rio de Janeiro dip circle No. 221 at *A*.[2]
	27	10 38	11 57	11.0	10.8	−0.2	
	27	12 54	14 17	16.8	15.3	−1.5	
Mean value of (I. M. S.—Rio de Janeiro 221)............						−0.7	

[1] All values are referred to station *A*; in 1915, $A=B-0'.8$, and in 1919, $A=C-1'.9$.

[2] The Rio de Janeiro values given are deduced from magnetograms of horizontal intensity and of vertical intensity, using for inclination base-line the value determined from the six sets of inclination observations made on September 26 and 27 with dip circle 221.

Assembling the results as already published in Volume II[a] and as given above, we have:

(14) I. M. S.—Rio de Janeiro (Cooke magnetometer No. 20) = +0′.5 (1913).
(14*a*) I. M. S.—Rio de Janeiro (Cooke magnetometer No. 20) = −0.00029*H* (1913).

[a] See *Res. Dep. Terr. Mag.*, Vol. II, pp. 253–254.

(14*b*) I. M. S.—Rio de Janeiro (Cooke magnetometer No. 25) = 0'.0 (1915–1919).
(14*c*) I. M. S.—Rio de Janeiro (Cooke magnetometer No. 25) = $-0.0034H$ (1915–1919).
(14*d*) I. M. S.—Rio de Janeiro (Dip circle No. 8075, needles 1 and 2) = −0'.7 (1915).
(14*e*) I. M. S.—Rio de Janeiro (Dip circle No. 221, 3 needles[a]) = −0'.7 (1919).

NO. 15.—ROME OBSERVATORY, ITALY.

Since the publication of results[b] obtained in 1911 and in 1913 from the comparisons of the magnetic instruments of the Ufficio Centrale di Meteorologia e Geodinamica at Rome, Professor Palazzo[c] has reported some small changes in the data originally given for his instruments. Because of improved values for azimuths of marks used and because of slight modifications in computations of horizontal intensity the mean results referred to I. M. S. become:

(15) I. M. S.—Rome (Dover magnetometer No. 122) = −0'.3 (1911–1913).
(15*a*) I. M. S.—Rome (Dover magnetometer No. 122) = $+0.00025H$ (1911–1913).
(15*c*) I. M. S.—Rome (Dover dip circle No. 51, needles 1, 2, 5, 6) = −0'.4 (1911–1913).

NO. 16.—SAMOA OBSERVATORY, AT APIA, UPOLU.

SERIES I, 1915.

The comparisons of May 1915 with the Samoa Geophysical Observatory at Apia, Upolu, Samoan Islands, were carried out by Dr. G. Angenheister for the Observatory and by Mr. W. C. Parkinson for the Department of Terrestrial Magnetism. The Observatory instruments were "Stations-theodolith" Tesdorpf magnetometer No. 2025 (magnet 12 for declination and magnets 12 and 38 for horizontal intensity) and Schulze earth inductor No. 2; the Department instrument was universal magnetometer C.I.W. No. 14 (magnet 14*L* for declination, magnets 14*L* and 14*S* for horizontal intensity, and needles 1, 2, 5, and 6 of No. 14 for inclination). The constants for Tesdorpf No. 2025 in horizontal intensity depend on standardizations made at the Potsdam Observatory; provided no change has taken place since these standardizations, the Samoa Observatory standard in horizontal intensity should be the same as that at Potsdam. For declination and inclination the observed values by the Observatory instruments are accepted without correction. The corrections on International Magnetic Standards for universal magnetometer C.I.W. No. 14 were as finally adopted.

The Observatory absolute observations were made on 4 piers, viz, north pier, designated *N*, of absolute observatory used for declination and deflection observations; southwest pier, designated *SW*, of absolute observatory used for oscillation observations; southeast pier, designated *SE*, of absolute observatory used for inclination observations; and west pier, designated *W*, outside of the absolute observatory for declination and horizontal intensity. *W* is 15 meters south 99° 04' west of and about ¾ meter lower than *N*. The C.I.W. observations for the 3 elements were made at stations *N* and *W*. The mark and azimuths adopted in the reductions are those used by the Observatory, viz, Tuamua Church, distant from *W* 3250 meters, azimuth from *W* south 96° 10'.1 west,[d] azimuth from *N* south 96° 10'.9 west.

It was not possible to effect complete simultaneous absolute observations with exchange of stations. One set of simultaneous observations for declination was made

[a] Needles 1 and 2 of 221, and 2 of No. 8075.
[b] See *Res. Dep. Terr. Mag.*, Vol. II, pp. 254–256.
[c] Palazzo, L., Misure magnetiche e confronti magnetometrici a Terracina, *Ann. dell Uff. Centra. Meteor. e Geod.*, Vol. 37, 1920.
[d] Mr. Parkinson's determination from morning and afternoon Sun observations gives the value from *W* south 96° 09'.0 west; the corresponding value from *N* would be south 96° 09'.8 west.

with No. 2025 at N and C.I.W. No. 14 at W, but for the one set of observations made on exchange of these stations the Observatory determination was 16 minutes later[a] than that by C.I.W. No. 14. One set of simultaneous observations for horizontal intensity was made with No. 2025 at N for deflections and at SW for oscillations with C.I.W. No. 14 at W, and one set of simultaneous observations with No. 2025 at W and C.I.W. No. 14 at N.[b] Schulze earth inductor No. 2 is a fixture on the southeast pier and it was, therefore, not possible to effect an exchange of stations. In view of the incompleteness of simultaneity of observation and exchange of stations it is thought best to base the comparisons upon the magnetograph data, the base-line values for which were obtained from absolute observations with the Observatory instruments in the absolute observatory at stations as stated in the paragraph above. Dr. Angenheister states that the station-differences between the 3 piers of the absolute house have been examined and found to be very small. The horizontal intensity at the north pier (N or I) appears to be about 3.5γ greater than at the southwest pier (SW or II) as determined from 6 sets on each pier and noted on page 43 of the publication[c] of the Observatory results for 1905–1908; thus, if both oscillation and deflection observations were made at N instead of at SW and N respectively, the Observatory values would be about 2γ greater. From 6 determinations made in January and February 1916, using Schulze earth inductor No. 2 at N and at SE and using magnetograph data for horizontal and vertical intensity to refer the results to the same times, Dr. Angenheister found that $N-SE=+0'.3$ (regarding dip, south end of needle down, as negative), the probable error of the mean of 6 differences being $\pm 0'.16$. Dr. Angenheister's judgment is, however, that the station-differences both for horizontal intensity and for inclination may be considered negligible.

TABLE 16A.—*Results of Declination Comparisons at the Samoa Observatory, 1915.*

Date	Local mean time		Declination obtained		I. M. S.—Samoa	Remarks
	From	To	I. M. S.[1]	Samoa[2]		
1915	h m	h m	° ′	° ′	′	
May 17	9 45	9 52	+9 51.8	+9 55.8	−4.0	C. I. W. at W.
17	11 03	11 10	52.7	55.7	−3.0	C. I. W. at W.
17	17 21	17 28	53.6	57.0	−3.4	C. I. W. at N.
19	14 51	14 58	53.4	57.2	−3.8	C. I. W. at N.
19	15 50	15 57	53.6	57.5	−3.9	C. I. W. at W.
Mean value of (I. M. S.—Samoa 2025)					−3.6	(weight 1.0)

[1] All I. M. S. values are referred to N; $N=W+0'.9$.

[2] The Observatory values are based upon magnetograph data, the base-line being controlled by 4 sets of declination observations at N during May 16 to 26, 1915.

[a] Dr. Angenheister reports, however, that the declination magnetogram shows no change for the interval of 16 minutes. Using only the 2 sets of absolute comparisons in declination referred to, the resulting value for (I. M. S.—Samoa) is $-3'.6$ and $N=W+1'.0$; the corresponding values from 5 determinations referred to the magnetograph (see Table 16A) are (I. M. S.—Samoa) $=-3'.6$ and $N=W+0'.9$.

[b] Using only the 2 sets of simultaneous absolute observations in horizontal intensity (I. M. S.—Samoa) $=+6\gamma$ or $+0.00017H$ and $N=W+58\gamma$ against corresponding values of (I. M. S.—Samoa) $=0\gamma$ or $0.00000H$ and $N=W+52\gamma$ from 3 determinations referred to the magnetograph (see Table 16B), the station-difference for horizontal intensity between N and SW being assumed negligible.

[c] Linke, F., und G. Angenheister, Ergebnisse der Arbeiten des Samoa-Observatoriums der königlichen Gesellschaft der Wissenschaften zu Göttingen. V. Die erdmagnetischen Registrierungen der Jahre 1905 bis 1908, Berlin, 1911.

TABLE 16B.—*Results of Horizontal-Intensity Comparisons at the Samoa Observatory, 1915.*

Date	Local mean time		Hor. int. obtained		I. M. S.—Samoa	Remarks
	From	To	I. M. S.[1]	Samoa[2]		
1915	*h m*	*h m*	γ	γ	γ	
May 17	9 56	11 02	35405	35406	−1	C. I. W. at *W*.
17	14 31	15 34	388	386	+2	C. I. W. at *N*.
20	10 21	11 27	401	402	−1	C. I. W. at *N*.
Mean value of (I. M. S.—Samoa 2025)..........					0.0γ or 0.00000*H* (weight 1.0)	

[1] All I. M. S. values are referred to *N*; $N = W + 52\gamma$.
[2] The Observatory values are based upon magnetograph data, the base-line being controlled by 4 sets of horizontal-intensity determinations, the oscillation observations being made at *SW* and deflection observations at *N* during May 16 to 26, 1915. It is assumed that the station-difference between *N* and *SW* is negligible.

TABLE 16C.—*Results of Inclination Comparisons at the Samoa Observatory, 1915.*

Date	Local mean time		Inclination obtained		I. M. S.—Samoa	Remarks
	From	To	I. M. S.[1]	Samoa[2]		
1915	*h m*	*h m*	° ′	° ′	′	
May 17	11 30	12 45	−29 50.8	−29 52.4	+1.6	C. I. W. at *W*.
17	15 56	17 06	50.2	52.7	+2.5	C. I. W. at *N*.
20	11 53	13 06	51.8	52.6	+0.8	C. I. W. at *N*.
Mean value of (I. M. S.—Samoa inductor 2)......					+1.6	(weight 0.5)

[1] All I. M. S. values are referred to *N*; $N = W + 1'.2$.
[2] The Observatory values are based on magnetograph data controlled by 3 sets of inclination observations at *SE* during May 15 to 20, 1915. It is assumed that station-difference between *N* and *SE* is negligible.

SERIES II, 1921.

Comparisons were again obtained at the Samoa Observatory in July 1921 by the *Carnegie* party. The observations with the Observatory instruments, the same as those used for the comparisons of 1915, were made by Director C. J. Westland and those with the C. I. W. instruments were made by Messrs. Johnston and Grumman, under the direction of Captain J. P. Ault, of the *Carnegie*. Some assistance in the C.I.W. work was given also by Dr. H. M. W. Edmonds and by Mr. D. G. Coleman of the Department's staff, the former being on special assignment to the Observatory in charge of the atmospheric-electric and allied meteorological observations and the latter being temporarily at Apia in the course of field work. The *Carnegie* instruments used were C.I.W. theodolite-magnetometer No. 5 and C.I.W. magnetometer-inductor No. 25. The finally adopted corrections on I.M.S. have been applied for all C.I.W. instruments.

The outside west pier, *W*, heretofore used for intercomparison work, was rejected for the present series as it was found to be constructed of magnetic material. Accordingly two new outside stations designated as *A* and *B* were established and used in addition to the north pier, *N*, and the southeast pier, *SE*, of the absolute observatory, occupied in previous comparisons. *A* is 50.51 feet and 48.53 feet from the northwest and southwest corners, respectively, of the concrete base of the atmospheric-electric laboratory, and 26.82 feet from the Observatory rain-gage. *B* is 50.32 feet from *A* towards the steeple of Tuamua Church across the bay in true bearing south 95° 46′.6 west. The Observatory value for the azimuth of the steeple of Tuamua Church from *N* was used, as in 1915, viz, south 96° 10′.1 west. After finding that the west pier was constructed of magnetic material, tests were also made of the piers in the absolute observatory. These, however, were found to be non-magnetic.

The observations were made as nearly simultaneously as possible. Simultaneous observations were also obtained with C.I.W. magnetometer-inductor No. 24 mounted

TABLE 16D.—*Results of Declination Comparisons at the Samoa Observatory, 1921.*

Date	Local mean time From	Local mean time To	Declination obtained[1] I. M. S.	Declination obtained[1] Samoa	I. M. S.—Samoa	Remarks
1921	h m	h m	° ′	° ′	′	
July 5	9 44	9 53	+10 10.7	+10 13.5	−3.0	C. I. W. magnetometer No. 5 at *A*; Samoa magnetometer No. 2025 at *N*.
5	9 56	10 05	10.4			
5	10 22	10 31	10.7	13.6	−3.0	
5	10 34	10 43	10.5			
5	11 22	11 31	10.0	12.9	−3.0	
5	11 34	11 43	09.7			
15	10 06	10 15	08.7	12.1	−3.5	C. I. W. magnetometer No. 5 at *N*; Samoa magnetometer No. 2025 at *A*.
15	10 18	10 27	08.5			
15	10 51	11 00	08.9	11.7	−2.6	
15	11 02	11 11	09.3			
15	11 24	11 33	09.1	12.2	−3.0	
15	11 36	11 45	09.4			
Mean value of (I. M. S.—Samoa)...............					−3.0	(weight, 3.0)

[1] All values are referred to *N*; $N = A - 1'.5$.

TABLE 16E.—*Results of Horizontal Intensity Comparisons at the Samoa Observatory, 1921.*

Date	Local mean time From	Local mean time To	Hor. int. obtained[1] I. M. S.	Hor. int. obtained[1] Samoa	I. M. S.—Samoa	Remarks
1921	h m	h m	γ	γ	γ	
July 1	10 26	12 05	35268	35263	+ 5	C. I. W. magnetometer No. 5 at *A*; Samoa magnetometer No. 2025 at *N*.
1	14 02	15 40	248	253	− 5	
2	10 14	11 56	263	254	+ 9	
8	11 32	15 37	259	250	+ 9	C. I. W. magnetometer No. 5 at *N*; Samoa magnetometer No. 2025 at *A*.
9	9 12	11 17	257	255	+ 2	
12	13 46	15 57	258	257	+ 1	
13	11 13	12 07	218[2]	274[2]	?	C. I. W. No. 5 at *A*; Samoa No. 2025 at *N*.
13	13 24	14 09	249[2]	235[2]	+14[2]	
Mean value of (I. M. S.—Samoa)...............					+ 4.3γ or +0.00012*H*	(weight, 3.0)

[1] All values are referred to *N*; $N = A + 4.8\gamma$. [2] Half set; weight 0.5.

TABLE 16F.—*Results of Inclination Comparisons at the Samoa Observatory, 1921.*

Date	Local mean time From	Local mean time To	Inclination obtained[1] I. M. S.	Inclination obtained[1] Samoa	I. M. S.—Samoa	Remarks
1921	h m	h m	° ′	° ′	′	
July 19	9 35	9 55	−30 (03.5)[2]	−30 04.0	+0.5	C. I. W. inductor No. 25 at *A*; Samoa inductor No. 2 at *SE*.
19	10 04	10 29	(03.2)[2]	03.8	+0.6	
19	10 38	11 10	(03.0)[2]	03.5	+0.5	
19	11 39	12 01	02.9	03.3	+0.4	C. I. W. inductor No. 25 at *B*; Samoa inductor No. 2 at *SE*.
19	13 13	13 25	03.2	03.5	+0.3	
19	13 30	13 40	03.2	04.0	+0.8	
20	9 22	9 36	03.9	04.4	+0.5	C. I. W. inductor No. 25 at *A*; Samoa inductor No. 2 at *SE*.
20	9 48	10 12	03.8	04.4	+0.6	
20	14 25	15 18	03.6	04.0	+0.4	C. I. W. inductor No. 25 at *SE*; Samoa inductor No. 2 at *A*.
20	15 25	15 38	03.7	04.2	+0.5	
20	15 58	16 11	04.2	04.9	+0.7	
20	16 14	16 29	04.4	04.8	+0.4	
20	16 42	16 58	04.9	05.5	+0.6	
20	16 59	17 09	04.5	05.1	+0.6	
Mean value of (I. M. S.—Samoa)...............					+0.5	(weight, 3.0)

[1] All values referred to *SE*; $SE = A - 3'.5 = B - 0'.7$.

[2] The resulting I. M. S. values at *SE* for the times shown were −30° 04′.1, −30° 03′.4, and −30° 03′.1 from which the values given in parentheses were interpolated for the local mean times of the Samoa values, viz, $10^h\ 11^m$, $10^h\ 41^m$, and $11^h\ 16^m$; the local mean times for all other Samoa values are so nearly the same as these for I. M. S. values that no interpolations for diurnal variation are necessary.

at W; because of the magnetic character of W the results have not been utilized. It is, however, interesting to note the general agreement of station-differences on W resulting from these observations. Thus the two values of station-difference $(N-W)$ in declination resulting from these observations and those with the other instruments at stations A and B are $+0'.6$ and $+0'.7$ respectively, giving a mean value of $+0'.7$ as compared with the 1915 value of $+0'.9$; the two values of station-difference $(N-W)$ in horizontal intensity are $+35\gamma$ and $+61\gamma$, giving a mean value of $+48\gamma$, which is in excellent agreement with the value of $+52\gamma$ determined in 1915.

SERIES PREVIOUS TO 1915.

On December 13, 1905, January 4, 30, 1906, and March 12, 1906, Mr. G. Heimbrod, observer of the Department, obtained 5 comparisons in declination between Tesdorpf magnetometer No. 2025 and the Samoa Observatory sub-standard (Tesdorpf magnetometer No. 1975$+0'.7$) observing with No. 2025 at the declination pier in the absolute observatory. Upon the completion of his field work in the Pacific islands with No. 2025 Mr. Heimbrod again on December 8, 9, 10, 13, 14, 1906, obtained 5 comparisons at the Samoa Observatory. The results were:

Tesdorpf No. 2025 − Samoa (Tesdorpf magnetometer No. 1975$+0'.7=$Potsdam[a])
$=+2'.45$ and $+2'.30$, respectively, or in the mean $=+2'.4$.

Since (see Vol. II, p. 253)

I. M. S. − Potsdam $=+0'.2$

we have:

(*a*) I. M. S. − Samoa (Tesdorpf No. 2025) $=-2'.2$

since all results at Samoa as published[b] and in manuscript are based on absolute observations by Tesdorpf magnetometer No. 2025 (magnet 12) with zero correction.

For horizontal intensity, since the relative constants used for Tesdorpf magnetometer No. 1975 are based on observations at Potsdam and since the relative constants for No. 2025 (magnets 38 and 12), the "station-instrument" at the Samoa Observatory, result from comparisons between Nos. 1975 and 2025 at Samoa, the Observatory standard is equivalent to that of Potsdam. For inclination also, since the standard at Samoa is Schulze earth-inductor No. 2 without correction and which when originally compared at Potsdam showed no correction on Potsdam standard, the Samoa standard is equivalent to that of Potsdam. Since (see Vol. II, p. 253)

I. M. S. − Potsdam $=+0.00008H$

and, for inclination,

I. M. S. − Potsdam $=+0'.2$

we have:

(*b*) I. M. S. − Samoa (Tesdorpf magnetometer No. 2025) $=+0.00008H$.
(*c*) I. M. S. − Samoa (Schulze inductor No. 2) $=+0'.2$.

Dr. Angenheister communicated in 1917, subsequent to the publication of Volume II, the final Observatory values applying for the times of the various C.I.W. observations at Samoa in 1906, 1907, and 1911, together with a summary from all sources of station-differences between the various piers and stations used for absolute observations. In view of the local natural and artificial magnetic-disturbances and magnetic

[a] The declination correction of Tesdorpf magnetometer No. 1975 on Potsdam standard determined at Potsdam by Dr. Linke in October 1904 was $+0'.7$ and in September 1907 was $+0'.74$ (see Vol. II, *Res. Dep. Terr. Mag.*, p. 252).

[b] Linke, F., und G. Angenheister, Ergebnisse der Arbeiten des Samoa-Observatoriums der königlichen Gesellschaft der Wissenschaften zu Göttingen. V. Die erdmagnetischen Registrierungen der Jahre 1905 bis 1908. Berlin, 1911.

TABLE 16G.—*Results of Comparisons at the Samoa Observatory, 1904 to 1911.*

No.	Date	Element	Values obtained[1] I. M. S.	Values obtained[1] Samoa	No. sets	I. M. S.—Samoa	Weight	Place of comparison
			° ′	° ′		′		
	Oct., 1904	D	... .	... .	?			Potsdam
1	Dec., 1905 / Dec., 1906	D	... .	... .	10	−2.2	2.0	Samoa, *N*
	Sept., 1907	D	... .	... .	?			Potsdam
2	May 3, 1906	D	+9 36.4	+9 37.8	2	−1.4[2]	1.0	Samoa, *N*
3	Mar. 5, 1907	D	+9 34.0	+9 39.9	2	−5.9	0.5[3]	Samoa, *W*
4	Mar. 6, 7, 1907	D	+9 34.5	+9 40.4	4	−5.9		Samoa, H_a
5	May 5, 6, 1911	D	+9 45.2	+9 50.3	5	−5.1	0.5[4]	Samoa, *N*
	Weighted mean value of (I. M. S.—Samoa)					−2.8	4.0	
			γ	γ				
6	1904–1909	H	.....	.....	?	+0.00008*H*	2.0	Potsdam & Samoa
7	Nov. 20, 1904	H	20079	20078	3	+0.00005*H*[5]	1.5	Cheltenham
8	May 3, 1906	H	35694	35683	1	+0.00031*H*[2]	0.5	Samoa, *N*
9	Mar. 5, 1907	H	35683	35682	1	+0.00003*H*	0.5	Samoa, *W*
10	Mar. 6, 7, 1907	H	35698	35692	2	+0.00017*H*	1.0	Samoa, H_a
11	May 5, 6, 1911	H	35535[6]	35539	1	+0.00017*H*	0.5	Samoa, *N*
	Weighted mean value of (I. M. S.—Samoa)					+0.00014*H*	6.0	
			° ′	° ′		′		
12	1904 (?)	I	....	....	?	+0.2	2.0	Potsdam
13	May 3, 4, 8, 1906	I	−29 13.1	−29 14.1	2½	+1.0[2]	0.5	Samoa, *N*
14	May 3, 4, 1906	I	−29 12.9	−29 14.4	5	+1.5	1.0	Samoa, *E*
15	May 3, 4, 1906	I	−29 13.9	−29 14.2	4	+0.3	1.0	Samoa, N_a
16	Dec. 8, 9, 10, 13, 1906	I	−29 18.0	−29 19.3	4	+1.3[2]	1.0	Samoa, *N*
17	Mar. 5, 6, 7, 1907	I	−29 12.2	−29 15.4	9	+3.2	0.5[3]	Samoa, H_a
18	Mar. 5, 6, 7, 1907	I	−29 12.6	−29 15.8	5	+3.2		Samoa, *W*
	Weighted mean value of (I. M. S.—Samoa)					+0.7	6.0	

[1] All values for Samoa apply for *N* or are referred to that station by the station-differences indicated in Table 16H; all Observatory values are based on the adopted Samoa standards, viz, Tesdorpf magnetometer No. 2025 for declination and horizontal intensity and Schulze earth-inductor No. 2 for inclination.
[2] *Cf. Res. Dep. Terr. Mag.*, Vol. II, p. 257.
[3] Small weight account suspected local disturbances because of construction work.
[4] Rain and mosquitoes greatly disturbed all observational work on May 5 and 6, 1911.
[5] See *Res. Dep. Terr. Mag.*, Vol. II, p. 252.
[6] Rejecting an apparently erroneous value 35484γ determined at $11^h\ 25^m$ on May 6, 1911.

material used in one of the piers (see Vol. II, pp. 256–257, and present volume, p. 453) only a general summary of these results is given in Table 16G. Since in most of these earlier series it was not always possible to have magnet systems of the several instruments at the same height above corresponding piers, small weights are given the results in Table 16G when combining them with others.

With reference to the various stations used, and to adopted values of station-differences, Dr. Angenheister in the report accompanying his letter of February 27, 1917, utilizing all comparison data through May 1915, says:

"During 1905 and 1906 all observations were taken on the single stone pier in the old absolute observatory. In the beginning of 1907 the old absolute house was replaced in the same location by a new house. In tearing down the old house an iron chisel was found in the roof between the sheathing and the roofing felt, just above the pier; this made observed values of negative inclination 3′.5 too small. (Correction has been applied accordingly to results obtained in 1905 and 1906.) There are 4 piers in the new absolute observatory, viz, *N*, *SE*, *SW*, and *SE corner-pier*. The galvanometer for inductor observations is mounted on the *SE corner-pier*. Inclination is observed on *SE*, oscillations for horizontal intensity are observed on *SW*, and deflections for horizontal intensity and declination are observed on pier *N*. The main pier, *N*, occupies the same place and has the same height as that of the old pier in the old absolute observatory. Its upper half since 1907 is made with lava-free, white sand; the old pier was made of sea sand containing lava. All results should be referred to *N*. The differences $(N-SW)=+3.5\gamma$, for horizontal

intensity, and $(N-SE)=+0'.3\pm0'.2$ for inclination, are so small and so little in excess of the observational errors that they may be disregarded for absolute observations and comparisons. Outside of the absolute observatory there are piers N_a[a] (15 meters north of N), E_a (15 meters east of N), and W_a[b] (15 meters west of N). Three meters northwest of N_a there stood in 1907 a wooden stump, H_a. Stations H_a and E were removed before 1917."

Table 16H summarizes the station-differences as given by Dr. Angenheister.

TABLE 16H.—*Summary of Station-Differences at Samoa Observatory, 1905 to 1917.*

Station-difference	Declination	Hor. int.	Inclination
	′	γ	′
$(N-SW)$	.....	+ 3.5	.....
$(N-SE)$	.....	......	+0.3
$(N-W_a)$	+0.9	+52	+1.2
$(N-N_a)$	.....	......	+0.6
$(N-H_a)$	−2.4	+48	+2.6
$(N-E)$	.....	......	+0.9

SUMMARY.

Table 16 I summarizes the results as given above.

TABLE 16 I.—*Summary of Corrections on Standards for Samoa Observatory.*

Date	(I. M. S.—Samoa)					
	Declination	Weight	Hor. int.	Weight	Inclination	Weight
	′				′	
1904–1911[1]	−2.8	4.0	+0.00014H	6.0	+0.7	6.0
1915, May	−3.6	1.0	0.00000H	1.0	+1.6	0.5
1921, July	−3.0	3.0	+0.00012H	3.0	+0.5	3.0

[1] See Table 16G.

Hence, we obtain weighted mean values as follows:

(16) I. M. S.—Samoa (Tesdorpf magnetometer No. 2025, magnet 12) = −3′.0 (1905–1921).

(16*a*) I. M. S.—Samoa (Tesdorpf magnetometer No. 2025, magnets 38 and 12) = +0.00012H (1905–1921).

(16*b*) I. M. S.—Samoa (Schulze inductor No. 2) = +0′.7 (1905–1921).

NO. 17.—STONYHURST COLLEGE OBSERVATORY, STONYHURST, ENGLAND.

The comparisons of 1915 were obtained for the Observatory by Reverend E. D. O'Connor, S. J., under the direction of Reverend W. Sidgreaves, S. J., Director, and for the Carnegie Institution of Washington by Observer E. Kidson. Two stations designated A and B were used. Station A was the wood-topped, sandstone pier regularly used for absolute observations in the magnetic hut by the Observatory. The tent station B was on the Observatory lawn, 39 feet northeast of the northeast corner of the north room of the main Observatory building, and 87.4 feet northwest of the west corner of an observing pier in the east corner of the lawn. At A, the Observatory azimuth mark, a cross painted on a slate roof, was used; the true bearing of the mark, supplied by Reverend Sidgreaves, was 337° 03′.3 west of south. At B, the left edge of the infirmary, about 800 feet distant, was used as an azimuth mark; its true bearing, determined by Observer Kidson, was 125° 57′.7 west of south.

The Observatory absolute instruments used were a Kew-pattern unifilar magnetometer by Jones, and Dover dip circle No. 159 with needles 1 and 2. The magnetom-

[a] The station designated Apia, *North Pier*, on page 100 of Volume I, *Res. Dep. Terr. Mag.*, is N_a and not N.

[b] Station W_a is designated *West Pier* or W in the C. I. W. results given in Volumes I and II, *Res. Dep. Terr. Mag.*

eter is one of the oldest of the Kew pattern manufactured by Jones and observation with it is somewhat difficult. The Observatory values for horizontal intensity depend upon a mean value of the distribution coefficient obtained from observations covering a period of 14 years. The C.I.W. instrument used was magnetometer-inductor No. 26. The corrections on International Magnetic Standards,[a] applied to results obtained with magnetometer-inductor No. 26, were those finally adopted.

TABLE 17A.—*Results of Declination Comparisons at the Stonyhurst College Observatory, 1915.*

Date	Local mean time		Declination obtained[1]		I. M. S.—Stonyhurst	Remarks
	From	To	I. M. S.	Stonyhurst		
1915	h m	h m	° ′	° ′	′	
Sept. 6	12 01	12 10	−16 39.8	−16 39.5	−0.3	C. I. W. No. 26 at *B*; Stonyhurst Jones unifilar at *A*.
6	14 48	14 57	38.5	38.5	0.0	
6	15 06	15 13	38.3	38.0	−0.3	
6	15 28	15 35	37.0	37.3	+0.3	
6	15 43	15 50	36.7	36.7	0.0	
6	15 57	16 04	36.7	36.7	0.0	
8	15 35	15 42	37.0	37.2	+0.2	C. I. W. No. 26 at *A*; Stonyhurst Jones unifilar at *B*.
8	16 18	16 25	35.6	36.0	+0.4	
8	16 32	16 39	35.0	34.3	−0.7	
8	16 54	17 02	34.8	34.8	0.0	
8	17 12	17 20	35.1	34.7	−0.4	
11	16 06	16 14	38.2	38.5	+0.3	
Mean value of (I. M. S.—Stonyhurst, Jones unifilar)					0.0	

[1] All values are referred to station *A*; $A=B-1'.0$.

TABLE 17B.—*Results of Horizontal-Intensity Comparisons at the Stonyhurst College Observatory, 1915.*

Date	Local mean time[1]		Hor. int. obtained[2]		I. M. S.—Stonyhurst	Remarks
	From	To	I. M. S.	Stonyhurst		
1915	h m	h m	γ	γ	γ	
Sept. 7	9 08	10 30	17312	17322	−10	C. I. W. No. 26 at *B*; Stonyhurst Jones unifilar at *A*.
7	10 41	12 00	32	47	−15	
8	9 32	10 45	19	07	+12	
9	9 34	11 27	22	36	−14	C. I. W. No. 26 at *A*; Stonyhurst Jones unifilar at *B*.
9	11 36	12 39	37	21	+16	
9	15 13	16 21	57	54	+ 3	
13	9 55	11 10	32	31	+ 1	C. I. W. No. 26 at *B*; Stonyhurst Jones unifilar at *A*.
13	14 26	15 44	56	35	+21	
Mean value of (I. M. S.—Stonyhurst, Jones unifilar)					+ 1.8γ or +0.00010*H*	

[1] The times given apply for the C. I. W. observations; the Stonyhurst College observations were not strictly simultaneous but the intervals between the mean times for corresponding sets are not large enough to affect materially the values for (I. M. S.—Stonyhurst), as indicated by the magnetograms.
[2] All values are referred to station *A*; $A=B+15\gamma$.

TABLE 17C.—*Results of Inclination Comparisons at the Stonyhurst College Observatory, 1915.*

Date	Local mean time		Inclination obtained[1]		I. M. S.—Stonyhurst	Remarks
	From	To	I. M. S.	Stonyhurst		
1915	h m	h m	° ′	° ′	′	
Sept. 7	14 58	15 27	+68 39.7	+68 42.2	−2.5	C. I. W. No. 26 at *B*; Stonyhurst dip circle No. 159 at *A*.
7	15 49	16 38	39.4	40.4	−1.0	
8	11 18	11 58	40.7	41.6	−0.9	
10	10 32	11 01	40.7	42.3	−1.6	C. I. W. No. 26 at *A*; Stonyhurst dip circle No. 159 at *B*.
10	11 30	12 01	40.5	43.0	−2.5	
10	14 59	15 27	39.9	40.0	−0.1	
Mean value of (I. M. S.—Stonyhurst, circle 159)...					−1.4	

[1] All values are referred to station *A*; $A=B-1'.4$.

[a] See *Res. Dep. Terr. Mag.*, Vol. II, pp. 270–278.

Assembling the results, we have:

(17) I. M. S.—Stonyhurst (Jones magnetometer) = 0'.0 (1915).
(17*a*) I. M. S.—Stonyhurst (Jones magnetometer) = +0.00010H (1915).
(17*b*) I. M. S.—Stonyhurst (Dover dip circle No. 159, needles 1, 2) = −1'.4 (1915).

NO. 18.—TANANARIVE OBSERVATORY, MADAGASCAR.

The comparisons of November 12 to 18, 1920, at the Tananarive Observatory of the Reverend E. Colin, S.J., were secured by Observer F. Brown at the beginning of his magnetic survey of Madagascar. Two stations, designated *A* and *B*, were occupied. Station *A* is the Observatory pier regularly used for absolute observations in the south room of the magnetic observatory, a small house of stone and unbaked brick (the magnetograph room is the second and north room of this building). Station *B* is 10.62 meters west of *A* in line with *A* and the Observatory azimuth mark, viz, the summit of Mount Ambohimalaza, 42 kilometers distant. Director Colin supplied the azimuth from *A*, as determined by the Observatory from 24 zenith-distance observations of the Sun, viz, 96° 45'.6 west of south. At station *B* the south tower of the Anglican Cathedral was used as a mark, its azimuth as determined by Mr. Brown and referred to the accepted Observatory azimuth for Mount Ambohimalaza being 89° 47'.7 west of south.

The Observatory instruments used in these comparisons were a Brunner magnetometer, medium-size model, made in Paris in 1889, and a Brunner dip circle, medium-size model with two needles, made in 1888 with one needle only. The declination and horizontal-intensity comparisons were made simultaneously at *A* and *B* with exchange of station made to eliminate station-differences, Director Colin observing with the Observatory instruments. All inclination comparison observations were made at station *A* by the alternate method, Mr. Brown observing with both instruments and following the Observatory practice with Observatory dip circle using the unnumbered needle regularly used at the Observatory; lack of time prevented Director Colin from making the Observatory observations for inclination. Because of existing known local disturbance care was exercised to have the magnet systems of each magnetometer at the same height above ground when observing at either *A* or *B*; the C.I.W. instrument was mounted on a block of wood on the pier at *A* to accomplish this. For the dip-circle work the magnetic center of the Observatory circle was one centimeter higher than that of the C.I.W. circle. Thus any possible question regarding erroneous station-difference because of variation in amount of local disturbance with height of instrument was eliminated. The magnitude of local disturbance is shown by the large station-differences observed. The C.I.W. instruments used were magnetometer No. 13 and dip circle No. 177 with needles 13X, 14X, 7 of No. 242, and 8 of No. 242.

The I.M.S. values given depend upon the constants and corrections as determined at Washington in March 1919, and may require modification later upon the return of the outfit in 1922.

Director Colin emphasizes in his letter of December 10, 1920, relating to the comparisons, the difficulties and uncertainties introduced by the great existing local disturbances at the Observatory site. He states that the intensity constants for his instrument have not been redetermined since the original determinations some 30 years ago. It is also difficult under the meteorological conditions in Madagascar to carry out observations of highest precision in a tent because of rapid temperature changes. He suggests the desirability of carrying out intercomparisons later by means of alternate observations for declination and horizontal intensity with the 2 instruments at one station only, making certain to have magnetic systems in each case at identical levels. As stated above, every care was exercised by Director Colin and Mr. Brown to have magnetic systems of the instruments at identical levels for observations at the same station.

TABLE 18A.—*Results of Declination Comparisons at the Tananarive Observatory, 1920.*

Date	Local mean time		Declination obtained[1]		I. M. S.—Tananarive	Remarks
	From	To	I. M. S.	Tananarive		
1920	h m	h m	° ′	° ′	′	
Nov. 12	9 58	10 07	−7 55.4	−7 61.7	+6.3	
12	13 00	13 09	48.2	54.0	+5.8	
13	7 10	7 17	55.8	61.8	+6.0	C. I. W. magnetometer No. 13 at *B*; Tananarive magnetometer at *A*.
13	8 31	8 40	56.9	61.1	+4.2	
13	8 47	8 56	57.0	60.7	?	
13	9 59	10 06	56.2	59.7	?	
16	10 25	10 34	57.3	62.6	+5.3	
16	10 38	10 47	56.8	61.0	+4.2	
16	12 57	13 06	49.9	56.0	+6.1	
16	14 21	14 28	49.6	56.7	+7.1	
17	7 09	7 18	55.3	60.9	+5.6	C. I. W. magnetometer No. 13 at *A*; Tananarive magnetometer at *B*.
17	8 40	8 49	57.3	62.1	+4.8	
17	8 58	9 07	57.3	62.2	+4.9	
17	10 23	10 32	56.6	60.5	+3.9	
Mean value of (I. M. S.—Tananarive)..........					+5.4	

[1] All values are referred to *A*; $A = B + 3'.2$.

TABLE 18B.—*Results of Horizontal-Intensity Comparisons at the Tananarive Observatory, 1920.*

Date	Local mean time		Hor. int. obtained[1]		I. M. S.—Tananarive	Remarks
	From	To	I. M. S.	Tananarive		
1920	h m	h m	γ	γ	γ	
Nov. 12	10 23	11 32	22067	22146	−79	C. I. W. magnetometer No. 13 at *B*; Tananarive magnetometer at *A*.
13	7 22	8 25	022	100	−78	
13	8 58	9 56	019	105	−86	
16	13 13	14 18	044	125	−81	C. I. W. magnetometer No. 13 at *A*; Tananarive magnetometer at *B*.
17	7 28	8 35	048	132	−84	
17	9 13	10 19	052	128	−76	
Mean value of (I. M. S.—Tananarive)..........					−80.7γ or −0.0037*H*	

[1] All values are referred to *A*; $A = B + 1048.4\gamma$.

TABLE 18C.—*Results of Inclination Comparisons at the Tananarive Observatory, 1920.*

Date	Local mean time		Inclination obtained		I. M. S.—Tananarive[1]	Remarks
	From	To	I. M. S.	Tananarive		
1920	h m	h m	° ′	° ′	′	
Nov. 13	11 34	12 12	−53	−53 21.4		
13	12 36	13 47	16.2	....		
13	14 42	15 50	16.8	....	+5.4	
13	16 15	16 48	....	22.4		
15	7 58	8 30	....	23.3		
15	8 52	10 08	16.7	....		
15	10 21	11 30	18.1	....	+4.9	Station *A* used throughout, C. I. W. circle No. 177 and Tananarive circle alternating.
15	11 52	12 20	....	21.3		
15	13 30	13 55	....	19.1		
15	14 16	15 26	17.7	....	?	
15	15 39	16 46[2]	17.7	....		
16	5 39	6 50	18.2	....		
16	7 10	7 35	....	21.2	+3.1	
18	7 02	7 30	....	20.8		
18	7 50	8 56	17.6	....		
Mean value of (I. M. S.—Tananarive)..........					+4.5	

[1] The individual differences show a range considerably larger than would be expected from simultaneous observations; this is, doubtless, because of diurnal-variation changes not entirely eliminated in the groupings, since intervals of time from beginning to end of comparisons are large.

[2] Heavy thunderstorm and darkness prevented observations with the Observatory circle.

Assembling the results we have:

(18) I. M. S.—Tananarive (Brunner magnetometer) = +5′.4 (1920).
(18*a*) I. M. S.—Tananarive (Brunner magnetometer) = −0.0037*H* (1920).
(18*b*) I. M. S.—Tananarive (Brunner dip circle) = +4′.5 (1920).

NO. 19.—WATHEROO OBSERVATORY, WESTERN AUSTRALIA.

The comparisons in September 1920 at the Watheroo Observatory of the Carnegie Institution of Washington were secured by the *Carnegie* party during the vessel's visit at Fremantle. Messrs. J. P. Ault, H. R. Grummann, and A. Thomson made the observations with the *Carnegie* instruments and Messrs. E. Kidson and W. C. Parkinson those with the Observatory instruments. The stations used were the piers N_m and S_m for declination and horizontal intensity and the piers N_w and S_w for inclination in the absolute house of the Observatory; piers N_m and S_m are on center line along the length of the absolute house near north and south ends respectively, while piers N_w and S_w are each 4 feet (1.22 meters) west of piers N_m and S_m; the distance between N and S piers is 25 feet (7.62 meters). The Observatory azimuth-marks were used, the azimuths as supplied by Mr. Kidson, observer-in-charge, being from N_m, 265° 06′.6 west of south, and from S_m, 263° 35′.9 west of south.

The Observatory instruments used in these comparisons were C. I. W. magnetometer No. 7 with correction on standard of −0′.2 in declination (reckoning east declination as positive) and of −0.00054*H* in horizontal intensity, and C. I. W. earth-inductor No. 2 with zero correction on standard. The *Carnegie* instruments were C. I. W. magnetometer No. 5 and C. I. W. marine earth-inductor No. 7. Throughout, the method of comparisons by simultaneous observations was employed, the observers exchanging stations to eliminate the station-differences. The corrections on I. M. S. for the *Carnegie's* instruments were those finally adopted.

The standards of the Observatory are the provisional International Magnetic Standards of the Department, and the results of the comparisons show that the corrections adopted when the instruments were last calibrated at Washington in April and May 1916 have been maintained practically unchanged.

TABLE 19A.—*Results of Declination Comparisons at the Watheroo Observatory, 1920.*

Date	Local mean time		Declination obtained[1]		I. M. S.—Watheroo	Remarks
	From	To	I. M. S.	Watheroo		
1920	*h m*	*h m*	° ′	° ′	′	
Sept. 13	9 04	9 13	−4 25.8	−4 26.1	+0.3	*Carnegie* C. I. W. No. 5 at S_m; Watheroo C. I. W. No. 7 at N_m.
13	10 55	11 04	26.4	26.2	−0.2	
13	13 34	13 43	20.0	21.0	+1.0	
13	15 33	15 42	18.7	18.9	+0.2	
14	8 41	8 50	24.8	24.5	−0.3	
14	11 03	11 12	26.1	26.0	−0.1	
14	13 20	13 28	21.9	22.4	+0.5	*Carnegie* C. I. W. No. 5 at N_m; Watheroo C. I. W. No. 7 at S_m.
14	14 54	15 04	19.0	19.0	0.0	
15	8 47	8 56	22.5	23.2	+0.7	
15	10 44	10 53	24.5	24.2	−0.3	
15	13 09	13 18	21.6	21.3	−0.3	
15	14 48	14 57	18.8	18.9	+0.1	
Mean value of (I. M. S.—Watheroo)............					+0.1	

[1] All values are referred to N_m; $N_m = S_m + 0'.4$.

TABLE 19B.—*Results of Horizontal-Intensity Comparisons at the Watheroo Observatory, 1920.*

Date	Local mean time From	Local mean time To	Hor. int. obtained[1] I. M. S.	Hor. int. obtained[1] Watheroo	I. M. S.—Watheroo	Remarks
1920	h m	h m	γ	γ	γ	
Sept. 13	10 14	10 52	24890	24886	+ 4[2]	*Carnegie* C. I. W. No. 5 at S_m; Watheroo C. I. W. No. 7 at N_m.
13	13 49	15 27	879	874	+ 5	
14	9 02	10 57	883	885	− 2	
14	13 32	14 49	865	874	− 9	*Carnegie* C. I. W. No. 5 at N_m; Watheroo C. I. W. No. 7 at S_m.
15	9 07	10 38	904	897	+ 7	
15	13 21	14 46	879	867	+12	
15	15 14	15 51	873	859	+14[2]	No. 5 at S_m; No. 7 at N_m.
Weighted mean value of (I. M. S.—Watheroo)....					+ 3.7γ or +0.00015H	

[1] All values are referred to N_m; $N_m = S_m - 1.0\gamma$. [2] Half set; weight one-half.

TABLE 19C.—*Results of Inclination Comparisons at the Watheroo Observatory, 1920.*

Date	Local mean time From	Local mean time To	Inclination obtained[1] I. M. S.	Inclination obtained[1] Watheroo	I. M. S.—Watheroo	Remarks
1920	h m	h m	° ′	° ′	′	
Sept. 16	8 55	9 17	−63 56.1	−63 56.0	−0.1	*Carnegie* C. I. W. No. 7 at S_w; Watheroo C. I. W. No. 2 at N_w.
16	9 22	9 39	55.6	55.8	+0.2	
16	10 08	10 23	55.8	55.7	−0.1	
16	10 31	10 44	55.7	55.7	0.0	
16	11 12	11 26	55.6	55.6	0.0	
16	11 34	11 48	55.5	55.5	0.0	
16	13 09	13 22	55.3	55.4	+0.1	*Carnegie* C. I. W. No. 7 at N_w; Watheroo C. I. W. No. 2 at S_w.
16	13 30	13 46	55.3	55.8	+0.5	
16	14 06	14 19	55.6	55.5	−0.1	
16	14 27	14 43	56.2	56.1	−0.1	
16	15 01	15 14	55.9	56.1	+0.2	
16	15 20	15 32	56.5	56.0	−0.5	
Mean value of (I. M. S.—Watheroo)............					0.0	

[1] All values are referred to N_w; $N_w = S_w + 0'.24$.

Assembling the results, we have:

(19) I. M. S.—Watheroo (C. I. W. magnetometer No. 7—0'.2)=+0'.1 (1920).
(19*a*) I. M. S.—Watheroo (C. I. W. magnetometer No. 7—0.00054H)=+0.00015H (1920).
(19*b*) I. M. S.—Watheroo (Toepfer inductor C. I. W. No. 2)=0'.0 (1920).

NO. 20.—WASHINGTON, D. C. (DEPARTMENT OF TERRESTRIAL MAGNETISM), AND FIELD COMPARISONS.

I. MAINTENANCE OF CONSTANCY OF STANDARDS.

The standardization of the field instruments used for the observatory comparisons during 1915 to 1921, determinations of instrumental constants, and necessary experiments, have been continued at the Standardizing Magnetic Observatory of the Department at Washington as before. For an account of the methods and specimen comparisons, see pages 262 to 264 of Volume II. Some idea of the large amount of work done in this connection can be readily formed by inspection of the results for the observations at Washington with C.I.W. standard magnetometer No. 3 and C.I.W. standard Schulze inductor No. 48 in the Table of Results (see particularly pp. 71–76). Most of these observations were made by Mr. H. W. Fisk, magnetician, to whose painstaking care and skill as an observer a large part of the credit for the successful establishment of satisfactory magnetic standards used in the Department's work must be given.

The question as to how closely various instruments after field work show constancy of correction is of course a vital one. It may be said that the many comparisons of the

numerous instruments used show, almost without exception, for each one a surprising degree of precision. It has been found that, while there are naturally large accidental errors at times in the field determinations of distribution coefficients, the elimination of such accidental errors with the accumulation of data indicates for magnetometers of the types used by the Department (see pp. 6–11) practical constancy. Thus for magnetometers No. 12 to 28, the magnets of all of which are of same size and style, the greater the number of determinations for the coefficient P' the more nearly the value approaches the mean for all the instruments. It has been found on the other hand that for those magnetometers the magnets of which are sheathed in brass changes of inertia must be expected in the course of field work.

The method of packing the long magnet is the same for all of the instruments having brass-sheathed magnets; the magnet, when not in use, fits snugly in a felt-lined cylinder. When in field service over any long period the change in inertia for these magnets is found to be practically linear with time. Investigations of such inertia changes have been made for each instrument. As typical examples of such work specimen compilations regarding C.I.W. magnetometers No. 19, 25, and 26 are given below.

C.I.W. magnetometer No. 19 has been used extensively and under severe transportation conditions for several trips in South America during 1912 to 1916.

The value of log π^2K, K being the moment of inertia about the axis of suspension for magnet 19L and its stirrup, determined February 28, 29, 1916, indicated a decrease of 0.00121 since the determination of June 18, 19, 1912, with the same inertia-bar. The equivalent change in the value of the moment of inertia for magnet 19L and its stirrup is 0.18 C. G. S. unit.

There appear to be three possible causes for such a change: (*a*) Loss of mass because of oxidation and because of constant rubbing and handling with consequent wearing of the magnet-sheath and stirrup in the course of field work; (*b*) a slight displacement of the friction-tight magnet in its brass sheath, possibly caused by frequent severe bumping and jolting of the instrument-case in transit, e.g., during numerous passages through rapids in the South American campaign of 1915, and (*c*) a shortening of the sheath possibly caused by impact during transportation.

Assuming the loss of mass according to the hypothesis (*a*) to be uniform in character the total change in the moment of inertia would be accounted for by a loss of about 0.08 gram. Such a loss may be reasonably probable in the course of several years' field use and might be expected to take place as a function of the time during which the instrument was in service. On the hypothesis (*b*) the change in the moment of inertia would require a displacement of the magnet of 1.3 millimeters. Such a displacement would affect materially the balance of the magnet when suspended; that is not the case and the hypothesis (*b*) is therefore rejected. A shortening of the magnet sheath amounting to 0.05 millimeter would cause a decrease in the moment of inertia of 0.06 C. G. S. unit. It is not probable that there could be a shortening of the sheath, due to crushing by impact, greater than 0.05 millimeter. It appears, therefore, that the change in the moment of inertia of magnet 19L and its stirrup may arise from a combination of the causes (*a*) and (*c*).

The effect of the decrease of 0.00121 in the value of log π^2K is such that values of the horizontal intensity, H, computed using the value of log π^2K first determined would be too great by 0.00139H. The difference indicated from the comparisons with the standard instrument at Washington in May 1912 and September 1915 is 0.00149H, which agrees substantially with the difference indicated by the observations for moment of inertia. Assuming that the change in the moment of inertia took place linearly during the period of field service, namely, between September 9, 1912 (1912.69), and September 24 to 28, 1915 (1915.73), the annual rate of change would be equivalent

to 0.000457H. That the change in the moment of inertia has been linear with time during the period of field service of the instrument is evidenced by the compilation of the differences on I. M. S. in horizontal intensity obtained from the comparisons at Washington, and given in Table 20A.

TABLE 20A.—*Corrections on I. M. S. in Horizontal Intensity for C. I. W. Magnetometer No. 19.*

Epoch of comparison	Weight	(I. M. S.—C. I. W. 19, constants of March 31, 1916)[1]	Correction for change in log π^2K		Corrected (I. M. S.—C. I. W. 19, constants of March 31, 1916)
			Δt		
1912.41	14	+0.00019H	0.00	0.00000H	+0.00019H
1914.10	12	−0.00056H	1.41	+0.00064H	+0.00008H
1914.16	3	−0.00045H	1.47	+0.00067H	+0.00022H
1914.92	6	−0.00035H	2.23	+0.00102H	+0.00067H
1915.15	2	−0.00064H	2.46	+0.00112H	+0.00048H
1915.73	13	−0.00130H	3.04	+0.00139H	+0.00009H
1916.15	10	−0.00125H	3.04	+0.00139H	+0.00014H
Weighted mean value of corrected (I. M. S.—C. I. W. No. 19, constants of March 31, 1916)................................					+0.00020H

[1] See p. 7.

It is to be noted that the difference on I. M. S. for magnetometer No. 19 is less than the value previously adopted. This improvement results (1) from the adoption of a value of the distribution coefficient P' resulting from all the data available since the construction of the instrument, and (2) from an improvement in the absolute value of the moment of inertia for inertia-bar No. 19, the bar used for both determinations of inertia of magnet 19L and its stirrup. The mean value of P' adopted for the constants of March 31, 1916, is +7.71 instead of +7.60 the value previously used; this change required corrections of +0.00010H and of −0.00010m to the values of horizontal intensity, H, and magnetic moment, m, computed on the basis that P' was +7.60. The original value of the logarithm of the moment of inertia for inertia-bar No. 19 was too small by 0.000279; this difference requires that additional corrections of +0.00032H and −0.00032m be applied to values of H and m determined using the original constants of the instrument.

As a result of the discussion, constants of date March 31, 1916, have been adopted for use with magnetometer No. 19 for all observations prior to March 31, 1916;[a] values of H and m computed by those constants require the corrections on account of the linear change in the value of the moment of inertia for magnet 19L and its stirrup.

C. I. W. magnetometer No. 25 was used at the shore stations of the *Carnegie*. Its performance is typical of what may be expected even under the most difficult conditions provided reasonable care is used. The long magnet, 25L, with its stirrup also showed a pronounced change in its moment of inertia while in field use. There was no change in the moment of inertia of magnet 5L and its stirrup for the second magnetometer, No. 5, used by the *Carnegie* party (see Table 20E). Thus through the comparisons made at shore stations between Nos. 5 and 25 we have an excellent series for investi-

[a] The results with C. I. W. magnetometer No. 19 during September 1912 to December 1913 (there were no field observations during January to February 4, 1914, the latter being the date on which the instrument was returned to the office) are already published in Volume II using a correction on C. I. W., on the basis of the constants of April 9, 1915, of +0.00039H which is equivalent to +0.00024H on I. M. S. The average correction on account of the change in the moment of inertia for magnet 19L and its suspension during September 1912 to December 31, 1914, to be applied to values of H computed by the constants of April 9, 1915, is −0.00030H. The published results, therefore, are given for an average corrected value of (C. I. W.—C. I. W. No. 19, constants of April 9, 1915) = +0.00069H or are equivalent to (C. I. W.—C. I. W. No. 19, constants of March 31, 1915) = +0.00027H; the final corrected value adopted for (C. I. W.—C. I. W. No. 19, constants of March 31, 1916) = +0.00035H, which leaves an outstanding difference of only 0.00008H. It is, therefore, not worth while to correct any of the results already published in Volume II, *Res. Dep. Terr. Mag.*, for C. I. W. magnetometer No. 19.

gating inertia change of No. 25. As will be seen from Table 20B a wide range of values was covered both in the Northern and in the Southern hemispheres. The adopted relation of C. I. W. to I. M. S. in horizontal intensity as indicated is from a least-square reduction of the data given in Table 20B on the assumption that the change in inertia was linear with time; the small range in the differences between values of $\Delta H/H$ computed by the resulting formula and actually observed values justifies the assumption that the inertia change was a linear one.

As regards the standard in inclination the evidence of field comparisons from earth-inductors is such as to leave no doubt as to the maintenance of a constancy of correction for all values of inclination well within the error of observation. As regards the correction on standard for dip circles, the detailed investigation and report on pages 359–371 shows the dip circle to be inferior to the earth inductor as an instrument of precision even when every care is taken to obtain frequent comparisons at different values of inclination.

TABLE 20B.—*Comparisons of C. I. W. Magnetometer No. 25, 1914–1918.*

No.	Date	Station	Approximate			Compared with	No. sets		(I.M.S.—C.I.W. No. 25)				
			D	H	I		D	H	D	W't	$\frac{\Delta H}{H}$	W't	Obs'd $\frac{\Delta H}{H}$ − computed $\frac{\Delta H}{H}$
			°	c. g. s.	°				′				
1	Jan. 29, 30, Feb. 2, May 16, 1914	Washington, A, C, and D	− 5	.192	+71	3[1]	21	8	−0.2	11	+0.00004	5	−0.00004
2	July 7, 8, 9, 1914	Hammerfest, A and B	− 2	.117	+77	5[2]	11	6	−0.6	5	−0.00006	3	−0.00007
3	July 23, 1914	Hammerfest, B	− 2	.117	+77	5	6	3	−1.0[3]	1	+0.00025[3]	1	+0.00025
4	Aug. 28, 29, Sep. 9, 1914	Reykjavik, A and E	−44	.118	+77	5	16	6	−0.6	8	−0.00003	3	0.00000
5	Nov. 6, 7, 9, 1914	Washington, S_m and N_m	− 5	.191	+71	3	14	6	−0.5	7	−0.00014	4	−0.00006
6	Nov. 18, 1914	Washington, N_m and O	− 5	.191	+71	3	12	...	−0.8	6	....	....	....
7	Feb. 2, 3, 1915	Washington, N_m	− 5	.190	+71	3	7	3	−1.0	1	−0.00034	3	−0.00020
8	March 29, 1915	Colon, A and B	+ 5	.322	+36	5	12	4	−0.2	6	−0.00029	2	−0.00011
9	May 27, 28, June 3, 4, 5, 1915	Honolulu Obs'y, A and B	+10	.290	+40	5	21	10	−0.4	10	−0.00006	4	+0.00017
10	July 22, 23, 24, 26, 11915	Dutch Harbor, A and B	+16	.209	+66	5	12	6	−0.2	6	−0.00010	3	+0.00016
11	Nov. 9, 10, 11, 12, 15, 1915	Christchurch, *brass pipe* and *jarrah peg*	+17	.224	−68	5	18	9	+0.1	9	−0.00015	4	+0.00019
12	Nov. 26, 1915	Christchurch, *absolute house* and *brass pipe*	+17	.224	−68	5	6	3	+0.3[3]	1	−0.00036[3]	1	−0.00001
13	Nov. 29, 1915	Christchurch, *peg* and *pipe*	+17	.224	−68	5	9	...	+2.2[3]	...	....	....	....
14	Apr. 4, 5, 6, 7, 17, 1916	Christchurch, *peg* and *pipe*	+17	.224	−68	5	14	6.5	−0.5	7	−0.00039	3	+0.00006
15	July 20, 21, 22, 1916	Sumay (Guam), A and B	+ 2	.350	+14	5	12	6	0.0	6	−0.00061	3	−0.00008
16	Sep. 29, Oct. 4, 1916	Goat Island, A and B	+18	.250	+62	5	12	6	−0.2	6	−0.00056	3	+0.00002
17	Mar. 13, 14, 15, 16, 1917	Pilar Obs'y, E and F	+ 8	.255	−26	5	14	6	−0.1	7	−0.00074	3	−0.00004
18	Oct. 24, 25, 26, 27, 29, 1917	Pilar Obs'y, E and F	+ 8	.254	−26	5	12	6	+0.4	6	−0.00075	3	+0.00013
19	Feb. 28, Mar. 12, 14, 1918	Lima, B and C	+ 9	.302	− 1	5	16	6	−1.1	8	−0.00106	3	−0.00011
20	June 17, 18, 21, 24, 25, 1918	Washington, N_m and S_m	− 5	.188	+71	3	12	6	−0.8	6	−0.00116	4	−0.00013
	Adopted weighted mean values for (I. M. S.—C. I. W. No. 25)								−0′.3		+0.00008 − (t—1914.22) 0.00026		

[1] C. I. W. standard magnetometer No. 3; see pages 7 and 10 for constants and corrections on I. M. S.
[2] See pages 7 and 10 and Table 20E for constants and corrections on I. M. S.
[3] These values result from observations without exchange of station.

C. I. W. magnetometer No. 26 is the sub-standard instrument of the Department and has been used for comparison work at a number of observatories. The following extracts from an extended study of its constants by Mr. H. W. Fisk are, therefore, given as a gage of the precision obtainable with field instruments. The series of comparison observations, four at the Standardizing Magnetic Observatory, Washington (S. M. O.), one at Cheltenham, and one each at four English observatories, viz, Kew, Greenwich, Stonyhurst, and Eskdalemuir. In making this study the ratios of the sines of the deflection angles at the different deflection-distances, r, are frequently employed, and are abbreviated for convenience, thus: $S_{21}=\dfrac{\sin u_2}{\sin u_1}$ and $S_{31}=\dfrac{\sin u_3}{\sin u_1}$.

TABLE 20C.—*Summary of the Results Obtained from Ten Series of Comparisons with C. I. W. Magnetometer No. 26.*

Epoch	Observatory	Magnetic moment at 20°C.	Distribution coefficient P'	$\Delta \log S_{21}$	$\Delta \log S_{31}$	$\Delta P'$	$\frac{\Delta H}{H}$	$\Delta \log C$
1914.71	S. M. O.....	324.95	7.85	−13	−27	+.06	+.00054	+2
1915.43	S. M. O.....	324.65	7.68	−91	+ 2	−.11	+.00046	+4
.45	Cheltenham.	324.57	7.85	+42	− 5	+.06	+.00047	+2
.49	S. M. O.....	324.52	7.89	+54	−11	+.10	+.00031	+4
.61	Kew........	324.43	7.79	+ 7	+ 3	.00	....	0
.68	Greenwich...	324.46	7.67	+22	+53	−.12	....	−5
.69	Stonyhurst..	324.49	7.88	− 6	−35	+.09	....	+3
.72	Eskdalemuir.	324.47	7.70	−14	+27	−.09	....	−3
.77	Kew........	324.35	7.87	− 9	−30	+.08	....	+3
1916.26	S. M. O.....	323.64	7.74	+ 5	+21	−.05	+.00021	−2

Table 20C shows that there has been a little change in the magnetic moment of the magnet, but not of such an extent as to suggest a possible source of error in the correction of the instrument. In the columns $\Delta \log S_{21}$ and $\Delta \log S_{31}$ the numbers represent the variation of the logarithm of the sine ratios from the mean of all, and are expressed in units of the sixth decimal. The second series at S.M.O. shows a rather unusual difference in $\Delta \log S_{21}$, and by a careful discussion in volume of constants for this instrument, it is shown to result from some peculiarity at the second distance, $r = 25$ cm. The quantity $\frac{\Delta H}{\Delta}$, observed value of (I.M.S.−C.I.W. No. 26) at S.M.O., seems to indicate a slow modification.

The quantities in the last column are the changes in the fifth decimal of the logarithm of the constant C, where

$$C = 2r^{-3}(1 + P'r^{-2})(1 - 2\mu r^{-3})$$

which would arise from the change in P', as shown in the column $\Delta P'$, if those changes had been carried over in the computation of log C (P' is the first distribution coefficient assuming that the second coefficient, Q, is zero, the dimensions of the long and short magnets being such as to make this theoretically the case). These variations are of too small an order to account for any considerable part of the change in constants under consideration, since $\Delta H/H = 1.15\,\Delta \log C$.

In order to test the value of each series, the probable error of $\log S_{21}$ and $\log S_{31}$ was found in each of eight series, four at S.M.O. and at Kew (two occupations combined), Greenwich, Stonyhurst, and Eskdalemuir, arranged in two groups. Table 20D following will show the value of the sine ratio and the probable error of that value as derived from the variations among the 12 to 20 individual sets in the several series.

TABLE 20D.

Observatory	Date	$\log S_{21}$	P. E.	$\log S_{31}$	P. E.	Δ21	Δ31
S. M. O.....	1914.71	9.706539	±32	9.557858	±25	−13	−27
S. M. O.....	1915.43	461	±17	887	±21	−91	+ 2
S. M. O.....	1915.49	606	±17	874	±31	+54	−11
S. M. O.....	1916.26	557	±10	906	±16	+ 6	+21
Means.....		9.706541		9.557881		−11	− 4
Kew........	1915.61	9.706559	±12	9.557888	±18	+ 7	+ 3
Greenwich...	1915.68	574	±16	938	±17	+22	+53
Stonyhurst..	1915.69	546	±12	850	±20	− 6	−35
Eskdalemuir.	1915.72	538	± 7	912	±16	−14	+27
Means.....		9.706554		9.557897		+ 2	+12

The logarithms and the probable errors are given in the sixth decimal. In general the determinations at the S.M.O. are not as good as those determined elsewhere. Probably the local effects of the electric car-line are to some degree responsible for this. Nevertheless none of the series is by itself such as to suggest anything unusual, or to cause any suspicion to be raised as to its accuracy. From all the available observations mean values of S_{21} and S_{31} have been used as follows: $\log S_{21} = 9.706552$ and $\log S_{31} = 9.557885$. The differences of each of the values above on these means are given under the heads Δ21 and Δ31. If therefore constants had been computed from the English group alone they would not have differed considerably from those obtained from the S.M.O. observations.

The results of standardizations of *C.I.W. magnetometer No. 5* are shown in Table 20E as typical of comparisons of instruments of its type. As noted above there is no evidence of any measurable change in the combined moment of inertia of magnet 5*L* and its stirrup. It is to be noted that the break in value of ΔD between 1918 and 1919 is caused by replacing of the old object lens of the magnetometer telescope by a new one.

TABLE 20E.—*Comparisons of C. I. W. Magnetometer No. 5, 1914–1921.*

No.	Date	Station	Approximate D	Approximate H	Approximate I	Compared with	No. sets D	No. sets H	(I. M. S.—C. I. W. No. 5) D	W't	$\frac{\Delta H}{H}$	W't
			°	c.g.s.	°				′			
1	May 13, 14, 1914[1]	Washington, *A*	−5	0.191	+71	3[2]	10	3	−0.3	1	−0.00078	0.5
2	Nov. 15, 16, 1914	Washington, S_m and N_m	−5	.191	+71	3	12	6	−1.1	2	−0.00040	2
3	Dec. 2, 1914	Washington, S_m and N_m	−5	.191	+71	3	12	..	−0.6	2	....	...
4	Feb. 3, 4, 1915	Washington, S_m	−5	.190	+71	3	6	3	−1.2	1	−0.00084	0.5
5	Jan. 17, 18, 19, 20, 1918	Washington, *O* and N_m	−5	.188	+71	3	12	6	−1.2	2	−0.00060	2
6	July 31, Aug. 1, 2, 7, 8, Sep. 2, 3, 1919	Washington, N_m and S_m	−5	.188	+71	3	16	6	−0.2[3]	2	−0.00051	3
7	Feb. 26, 28, Mar. 1, 1921	Fort Scott, *A* and *B*	+18	.247	+62	26[4]	16	6	−0.3	1	−0.00066	3
	Weighted mean values of (I. M S.—C. I. W. No. 5.)								−0.9[5] / −0.2[6]		−0.00058[7]	

[1] The instrument was reconstructed before these standardizations were made.
[2] C. I. W. standard magnetometer No. 3; see pages 7 and 10 for constants and corrections on I. M. S.
[3] A new object lens was mounted in the magnetometer telescope before these standardizations were made.
[4] C. I. W. sub-standard magnetometer No. 26; see pages 7 and 11 for constants and corrections on I. M. S.
[5] This value applies for period 1914 to 1918.
[6] This value applies for period 1919 to 1921 (see foot-note 3).
[7] The correction given on page 10 and used in the Table of Results (see pp. 30 to 97) through 1920 is −0.00054, the weighted mean value of comparisons through 1920, Nos. 1 to 6.

II. ABSOLUTE STANDARD IN HORIZONTAL INTENSITY.

Upon completion in May 1921 of C.I.W. sine galvanometer No. 1 according to the design by Dr. Barnett, for whose description of the instrument see pages 373 to 394, an investigation of the relation between it and the adopted I.M.S. in horizontal intensity was begun under the author's direction. On June 3 and 4, and on August 2, 4, 5, and 8, 1921, simultaneous comparison observations with the sine galvanometer and the standard C.I.W. magnetometer No. 3 were made at stations N_m and S_m of the Standardizing Magnetic Observatory at Washington.[a] The following particulars are from the preliminary account of the results submitted by Messrs. Fleming, Fisk, and Ives; a complete report will be published later.

The instruments used for determining current through the sine galvanometer were a Wolff standard 10-ohm resistance, a Weston standard cell, a portable, field-type galvanometer (see Vol. II, p. 14), and a Wolff potentiometer; the potential difference

[a] See *Res. Dep. Terr. Mag.*, Vol. II, pp. 185–200.

between the terminals of the standard resistance, which was in series with the instrument, was determined by the potentiometer method. The current through the sine galvanometer was obtained from a lead storage battery; the maximum currents used were from 0.14 to 0.15 ampere, the single deflection-angles being from 65° to 74°. The values of horizontal intensity determined by the sine galvanometer are in absolute units, the degree of precision depending upon the magnitudes of any errors in the electrical measurements and in the determinations of the constants for the sine galvanometer.

The formula (*cf.* pp. 391–392) for the measurement of horizontal intensity, H, by the sine galvanometer is

$$H = \frac{G_t E C}{R_{t'} \sin u}$$

where G_t = the constant of the sine galvanometer at the temperature t, E = voltage across the standard resistance, $C = \left[1 + \frac{1}{2}(L - R)\left(\cot u - \frac{h}{f \sin u}\right)\right]$, $R_{t'}$ = resistance of the standard resistance at the temperature t', u = single deflection-angle of the magnet, L = scale reading when magnet is deflected clockwise, R = scale reading when magnet is deflected counter-clockwise, and h = angle through which magnet is turned when torsion head is turned through an angle f. According to calculations made by Dr. Barnett, G is known to 1 part in 30,000. The temperature coefficient of G per degree centigrade is -9×10^{-6}. An error of 1° in temperature of the coils will, therefore, make an error in G of less than 1 part in 100,000. The electrical instruments used in the preliminary work were calibrated by the United States Bureau of Standards with a precision somewhat better than 0.01 per cent each for the potentiometer and for the standard cell and of about 0.005 per cent for the standard resistance. The several temperature coefficients are well determined; because of the excellent insulation of the Standardizing Magnetic Observatory variations in temperature during the comparisons were very small and gradual. Thus the combined maximum error for a single determination as regards the electrical measurements might be about one part in 4,000, but as it is unlikely that the errors are all in the same direction the actual mean error for a complete observation is doubtless less than one part in 10,000. Thus the error for a determination of H is probably not more than one part in 7,000.

Throughout the comparisons the author had the counsel of his colleague, Dr. S. J. Barnett, who also took part on June 2 in the preliminary work and in the set-up of the accessory apparatus. The observations with the sine galvanometer were made continuously during the intervals during which Mr. Fisk observed with the C. I. W. standard magnetometer No. 3; Messrs. Fleming and Peters observed with the sine galvanometer on June 3 and 4, and Messrs. Fleming and Ives on August 2, 4, 5, and 8. Since a complete determination with C. I. W. sine galvanometer No. 1 rarely took over 2 minutes of time the results constitute practically diurnal-variation series for the periods of comparison, and simultaneous mean values applying for the intervals of oscillation and deflection observations (at 3 distances, 25, 30, and 40 cm.) with magnetometer No. 3 were readily obtained. To eliminate any question as to possible disturbing effects of any slightly magnetic parts of the instruments 3 foot-screw orientations were used. The results indicate that there is no such measurable effect. Stations and instruments were also interchanged as indicated in Table 20F, which gives the data obtained from the comparisons.

A few observations were made also on June 2 but these are not reported in Table 20F for the reason that the reversing switch used was not in good condition and great trouble was experienced because of large and rapid variations in the electromotive force of the storage battery on that day because the battery was drawn upon unexpect-

edly for heavy current for other laboratory use. Each value on June 3 and 4 by magnetometer No. 3 (correction on I. M. S. being zero for constants of December 12, 1910, see p. 10), depends upon 2 sets of deflection observations only at 3 distances using a mean value of magnetic moment determined from a number of complete observations both preceding and following the comparisons. For the work in August each I. M. S. value depends upon a complete determination by magnetometer No. 3, i.e., 2 sets of deflection observations at 3 distances preceded and followed by oscillation observations.

TABLE 20F.—*Results of Horizontal-Intensity Comparisons between C. I. W. Standard Magnetometer No. 3 and C. I. W. Sine Galvanometer No. 1, at Washington, 1921.*

Series	Date	Local mean time From	Local mean time To	Hor. int. obtained[1] I. M. S.	Hor. int. obtained[1] S. G. 1	I. M. S. − S. G. 1	Weight	Station M. 3	Station S. G. 1
	1921	h m	h m	γ	γ	γ			
I[2]	June 3	14 27	15 18	18720.4	18720.2	+0.2	0.5	N_m	S_m
	3	15 32	15 53	695.6	696.0	−0.4	0.5		
	4	9 27	10 02						
	4	10 33	11 21	661.8	662.2	−0.4	0.5	S_m	N_m
	4	11 23	11 42	669.9	669.5	+0.4[3]	0.2		
Weighted mean value of (I. M. S.—S. G. 1)............						−0.1γ or −0.00001H			
II[4]	Aug. 2	12 03	14 37	18689.4	18693.6	−4.2	1.0	S_m	N_m
	2	14 55	15 50	711.6	708.0	+3.6[3]	0.5		
	4	9 43	11 18	663.8	659.6	+4.2	1.0		
	4	11 42	12 26	679.6	676.4	+3.2	1.0		
	4	13 29	14 07						
	4	14 30	16 01	686.6	690.8	−4.2	1.0		
	5	9 42	11 14	638.5	638.4	+0.1	1.0	N_m	S_m
	5	11 39	12 22	660.0	661.5	−1.5	1.0		
	5	13 28	14 09						
	5	14 25	16 16	669.6	667.4	+2.2	1.0		
	8	0 05	1 40	675.1	674.9	+0.2	1.0		
	8	1 50	2 32	672.0	679.3	−7.3[3]	0.5		
	8	3 03	4 38	678.2	680.6	−2.4	1.0	S_m	N_m
	8	4 51	5 40	665.3	673.1	−7.8[3]	0.5		
Weighted mean value of (I. M. S.—S. G. 1)............						−0.8γ or −0.00004H			
Weighted mean value[5] of (I. M. S.—S. G. 1) from I and II..						−0.7γ or −0.00004H			

[1] All values are referred to station N_m using station-difference determined from each series, viz: for I, $N_m=S_m+6.6\gamma$; for II, $N_m=S_m+5.6\gamma$.
[2] Each value given in series I for magnetometer No. 3, except as noted, is from 2 sets of deflections only at 3 distances using value of magnetic moment interpolated from extended complete determinations preceding and following this work.
[3] Half set.
[4] Each value given in series II for magnetometer No. 3, except as noted, is from a complete determination, viz., oscillations, deflections at 3 distances, second set of deflections at 3 distances, and second set of oscillations.
[5] Probable error of the weighted mean value is ±0.6γ or ±0.00003H, and that of a single determination of weight one is ±2.0γ or ±0.00011H.

The conditions for comparison work were by no means good as moderate magnetic storms were in progress on June 3, p. m., to June 4, on the afternoons of August 2 and 3, on August 5, and during the early morning of August 8. As has already been stated there are slight effects occasioned by the electric car-lines about ⅝ mile west of the Standardizing Magnetic Observatory; these apparently are eliminated in the mean of observations taken over the short period required for a set of oscillations or of deflections by the magnetometer or for a complete determination by the sine galvanometer. The agreement of I. M. S. and C. I. W. sine galvanometer is surprisingly close and indicates that the standard in horizontal intensity adopted for the discussion of various results in Volume II, pages 270 to 278, is correct within one part in 10,000.[a] The prob-

[a] It is merely a coincidence, but nevertheless interesting, that in a special report by Messrs. John A. Fleming and Harlan W. Fisk, not yet published ("Discussion of magnetometer-corrections on standards in declination and horizontal intensity") investigating, among others, the long series of observations during 1907 to 1921 by C. I. W. standard magnetometer No. 3, the final values for mean distribution coefficients, mean inertia, and correction because of bending of deflection bar, indicate that values by No. 3 should be increased by 0.00004H.

able error of a single determination of the difference (I. M. S. − C. I. W. sine galvanometer No. 1) certainly indicates that well designed magnetometers with carefully determined constants are capable of an absolute precision of 0.00015H.

III. SUMMARY OF MEAN CORRECTIONS ON I. M. S.

Table 20G summarizes the mean corrections on I. M. S. for various instruments and observatories as determined from all the data considered in this and in the first report (see Vol. II, pp. 211–278) and obtained during the 15 years from 1907 to 1921. The weighted mean corrections resulting are practically zero for ΔD, $\Delta H/H$, and ΔI. Thus with the additional evidence afforded by the results of the comparisons between I. M. S. and absolute values derived from the sine galvanometer (see Table 20F) there seems little doubt that, for all practical theoretical investigations, the provisional international standards designated as "I. M. S." in Volume II are correct well within the errors of observation and of the determination of constants.

TABLE 20G.—*Summary of Mean Corrections on I. M. S. for Various Instruments and Observatories, 1907–1921.*

No.	Based on	Declination correction		Horizontal-intensity correction		Inclination correction			
						Earth inductor		Dip circle	
		ΔD	Weight	$\frac{\Delta H}{H}$	Weight	ΔI_{ei}	Weight	ΔI_{dc}	Weight
		′				′		′	
I	Means of 17 magnetometers constructed by the Department, similar to types[1] 1(*b*), 4(*b*), and 4(*c*), from comparisons at Washington (17 values for ΔD and ΔH, 6 for ΔI_{ei}, 5 for ΔI_{dc}).....	−0.34	2.0	+0.00010[2]	2.0	0.00	1.0	+0.04	0.5
II	Mean of 3 earth inductors constructed by the Department, similar to type (*b*),[1] from comparisons at Washington.......	......	......	....	......	−0.11	0.5	......	......
III	Means of 9 magnetometers constructed for the Department by Bausch, Lomb, Saegmueller Co., similar to type 2(*b*),[1] from comparisons at Washington.......	−0.09	1.0	−0.00001[3]	1.0	......	......	......	......
IV	Mean of 9 land dip-circles constructed for the Department by Dover, similar to type (*a*),[1] from comparisons at Washington....	......	......	....	......	......	......	−0.01	1.0
V	Mean of 5 earth inductors constructed by Schulze and by Toepfer for the Department, similar to type (*a*),[1] from comparisons at Washington.......	......	......	....	......	−0.03	1.0	......	......
VI	Mean of direct C. I. W. comparisons at 27 observatories excluding differences exceeding allowable limits (means from 23 values for ΔD, 21 for ΔH, 17 for ΔI_{ei}, 11 for ΔI_{dc})................	+0.11	3.0	−0.00003	3.0	+0.12	2.0	−0.35	1.0
VII	Means of indirect comparisons at 15 observatories excluding differences exceeding allowable limits (means from 8 values for ΔD, 14 for ΔH, 9 for ΔI_{ei}, 5 for ΔI_{dc}).......	+0.10	1.0	−0.00003	1.0	+0.07	0.5	−0.32	0.2
	Weighted mean corrections on I. M. S. for various instruments and observatories, 1907–1921......................	0.0	......	+0.00001	......	+0.04	......	+0′.02	......
						0′.0			

[1] See p. 6; *cf.* also *Res. Dep. Terr. Mag.*, Vol. I, pp. 2–12, and Vol. II, pp. 5–15.
[2] Correction applied to computed values of H account of bending of deflection bar, −0.00008H.
[3] Correction applied to computed values of H account of bending of deflection bar, −0.00012H.

NO. 21.—VARIOUS ADDITIONAL OBSERVATORIES.

I. MEANOOK OBSERVATORY, 1917.

During August 30 to September 3, 1917, comparisons[a] were made under the direction of Sir Frederick Stupart by H. E. Cook, resident observer, at the Meanook Magnetical Observatory of the Meteorological Service of Canada. The station instrument for declination and horizontal intensity is Elliott magnetometer No. 48 and for inclination is Dover dip circle No. 200. The correction on I.M.S. in declination was obtained by comparison based on magnetograph data, the base-line value being determined by a series of observations with Meteorological Service C.I.W. magnetometer No. 15 (see p. 402 for correction of No. 15 on I.M.S.). From the comparisons the following mean result (probable error of $\pm 0'.06$) was adopted:

(*a*) I.M.S.—Meanook (Elliott magnetometer No. 48) = $-0'.5$ (1916–1917).

(The corrections on I.M.S. for Elliott magnetometer No. 48 determined in September and October 1906 at Agincourt (see Vol. II, p. 214) were $0'.0$ in declination and $-0.00056H$ in horizontal intensity, with some uncertainty, however, because of possible small station-differences.)

Mr. Jackson also reports in the same reference[a] that the correction on I.M.S. used for the Meanook results as determined at Agincourt in 1914 and adopted was:

(*b*) I. M. S.—Meanook (Elliott magnetometer No. 48) = $+0.00031H$ (1917).

(This value does not agree with the 1906 results at Agincourt, doubtless because the intensity constants used for No. 48 in 1906 have been superseded.)

Apparently the observed results with Dover dip circle No. 200 are accepted without correction. In 1912 the following relation was determined at Agincourt (see Vol. II, p. 216):

Toepfer inductor No. 89—Dover circle No. 200 (needles 1, 2) = $+0'.11$.

Since from page 400,

I. M. S.—Toepfer inductor No. 89 = $-0'.15$

we have:

(*c*) I. M. S.—Meanook (Dover dip circle No. 200, needles 1, 2) = $0'.0$ (1912).

II. SERIES OF COMPARISONS DURING 1913 BY SUPERINTENDENT RICHARDSON OF THE ESKDALEMUIR OBSERVATORY.[b]

During May to August 1913 Mr. L. F. Richardson, superintendent of the Eskdalemuir Observatory of the Meteorological Office, visited the magnetic observatories at Kew, Greenwich, Valencia, Falmouth, Val Joyeux, De Bilt, and Potsdam. Comparisons of the field outfit were made at Eskdalemuir, June 19–24, 1913, after obtaining comparisons at the first three observatories named, and again in August 1913 at the end of the field work. The traveling instruments used by Mr. Richardson were Dover unifilar magnetometer No. 40 and Dover dip circle No. 120. They were standardized at Eskdalemuir by comparison with the magnetograms using base-values determined by the then standard instruments of the Observatory, viz, Elliott magnetometer No. 60 and dip circle No. 74. The resulting observed differences on the field instruments were then referred to Eskdalemuir by the mean relations determined there, viz:

(1) Eskdalemuir (Elliott magnetometer No. 60)—Dover magnetometer No. 40 = $-0'.8$.[c]
(2) Eskdalemuir (Elliott magnetometer No. 60)—Dover magnetometer No. 40 = -13.4γ or $-0.00080H$.[d]
(3) Eskdalemuir (Dover dip circle No. 74)—Dover dip circle No. 120 = $+2'.3$.

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[a] See "Results of Observations in the Canadian Magnetical Observatories Agincourt and Meanook for the Year 1917," by W. E. W. Jackson, Ottawa, 1920, pp. 33–34.

[b] See "Report by the Superintendent of the Observatory, Eskdalemuir, upon a visit in 1913 to various observatories for the purpose of comparing magnetic standards," by L. F. Richardson. British Meteorological and Magnetic Year Book, 1913, part IV, section 2, Edinburgh, 1915, pp. 83–89.

[c] East declination being reckoned as positive.

[d] Differences in H are expressed in gammas only throughout Mr. Richardson's report; H for Eskdalemuir at time of comparisons was 0.1682 C. G. S. unit.

The standard instruments at Eskdalemuir in 1915, when comparisons were made there by the Department, were Elliott magnetometer No. 60 and Schulze earth-inductor No. 103; the latter instrument replaced dip circle No. 74 in 1914. From the data given in the British Meteorological and Magnetic Year Book for 1914 by the graph of vertical-intensity base-line values determined, during January to September 1914, by inductor No. 103 and by circle No. 74, respectively, we compute the relation

(4) Eskdalemuir (Schulze inductor No. 103) − Dover dip circle No. 74 = −1′.1.

which was used to refer the inclination results reported by Mr. Richardson to the Observatory standard in 1915.[a]

Table 21A gives a summary of the data obtained from Mr. Richardson's comparisons and of the resulting differences on I.M.S. for the various observatories visited as determined by the relations determined at Eskdalemuir in 1915 (see pp. 422–423). The values for the observatories were generally taken from the magnetograms and were for the periods of observation by Mr. Richardson except at Valencia and Falmouth. At Valencia absolute observations were made by the Superintendent. At Falmouth, owing to loss of magnetograms, it was necessary to use observations made preceding and following the comparisons and deduce values corresponding to the times of comparison by reference to diurnal-variations on magnetically quiet days.

TABLE 21A.—*Comparisons on I. M. S. Resulting Indirectly from Comparisons between Eskdalemuir Magnetic Standards and Certain Observatory Standards.*

[The results as published in Mr. Richardson's report have been modified here as follows: (*a*) the signs of the declination differences (Δ*D*) have been reversed in order to correspond with east declination taken as positive; (*b*) the horizontal-intensity differences (Δ*H*) have been expressed in parts of *H* with the aid of the values of *H*, as given in the report, for the observatories and referred to Eskdalemuir by formula (2) above; (*c*) the inclination differences (Δ*I*) have been referred to Schulze inductor No. 103, the 1915 standard instrument at Eskdalemuir, by formula (4) above.]

No.	Observatory	Date	(Eskdalemuir—Observatory)[1]			Resulting (I. M. S.—Observatory)			Observatory instruments[2]	
			ΔD	$\frac{\Delta H}{H}$	ΔI	ΔD	$\frac{\Delta H}{H}$	ΔI	Magnetometer	Inclinometer
		1913	′		′	′		′		
22	De Bilt	July 12, 14, 15	−0.6	+0.00060	{+0.8 / +1.3}	−1.4	−0.00037	{+0.7 / +1.2}	Edelmann[3]	{Weber EI. / Schulze EI. 88.}
23	Falmouth[4]	{June 28, 30 / July 1, 2, 3}	+0.7	+0.00074	+0.3	−0.1	−0.00023	+0.2	Elliott 66	Dover DC. 86; 1, 2.
6A	Greenwich	June 6, 7	......	+0.00168	−0.7	......	+0.00071	−0.8	Gibson 3[5]	EI.
10A	Kew[6]	June 3, 4	+1.3	+0.00023	−0.6	+0.5	−0.00074	−0.7	Jones	Barrow DC. 33; 1, 2.
24	Potsdam	July 17, 18, 19, 21	−0.8	+0.00039	+0.9	−1.6	−0.00058	+0.8[7]	Wanschaff	Schulze EI. 1.
25	Val Joyeux	July 8, 9	−0.3	−0.00012	+4.6	−1.1	−0.00099	+4.5	Chasselon 37	Brunner DC.
26	Valencia	June 11, 12, 13	+2.1	+0.00082	+0.7	+1.3	−0.00015	+0.6	Dover 139	Dover DC. 118.

[1] The values given depend upon number of sets as follows: Δ*D*, two at each observatory except for Kew and Val Joyeux where only one each; Δ*H*, one each at Greenwich and Kew, two each at Valencia, De Bilt, and Val Joyeux, three at Potsdam, and four at Falmouth; Δ*I*, two each at Falmouth, Valencia, and Potsdam, and one each at Greenwich, Kew, De Bilt, and Val Joyeux.

[2] These data taken from publication of each observatory for 1913.

[3] The declinations are observed with a special declinometer.

[4] Mr. Richardson states "A chip from one of the bricks of the observing pier at Falmouth was tested at Eskdalemuir and found to have a magnetic susceptibility (per unit volume) of about 1.2 x 10^{-3} C. G. S. unit. As magnetometer 40 and dip circle 120 were almost identical in size and form with those used by the Observatory the pier would affect both equally and be without influence on difference between them."

[5] Declinometer used for declination.

[6] Magnetograms were seriously disturbed by building operations.

[7] See page 473.

[a] According to data given on page 72 of the British Meteorological and Magnetic Year Book, part IV, section 2, for 1914, the mean value at Potsdam (probably sometime in 1913) from three determinations for (Potsdam—Schulze inductor No. 103) was −0′.05; thus we have indirectly, since (I. M. S.—Eskdalemuir) = −0′.10, (I. M. S.—Potsdam) = 0′.0 which is in substantial agreement with the directly observed value of +0′.2 determined in 1910 (see Vol. II, p. 253).

III. SERIES OF COMPARISONS DURING 1898 AND 1902 BY PROFESSOR PALAZZO.

From Professor Palazzo's final values[a] (see p. 451) for the results of the C. I. W. comparisons with his instruments in 1911 and 1913, we may obtain, through his excellent series of comparisons in 1898 and 1902, the corrections on I. M. S. for the observatories at Parc St. Maur and Kew in 1898 and at Potsdam and Pola in 1902. Professor Palazzo used the same instruments for all comparison observations, viz, Dover magnetometer No. 122 and Dover dip circle No. 51 with needles 1 and 2. The observed data and resulting corrections on I. M. S. for Kew, Pola, and Potsdam, as presented in Table 21B, show substantial agreement with the values obtained directly at these observatories. This is particularly the case for Kew indicating for that observatory an excellent constancy of standards from 1898 to 1919 in declination and inclination and from 1898 to 1910 in intensity (see p. 441). Therefore we may expect the resulting values as given in Table 21B for (I. M. S. − Parc St. Maur) to be good.

TABLE 21B.—*Comparisons on I. M. S. Resulting Indirectly from Comparisons between Rome Magnetic Standards and Certain Observatory Standards.*

[The results published in Professor Palazzo's report have been modified here as follows: (*a*) the signs of the declination differences (ΔD) have been reversed in order to correspond with east declination taken as positive.]

No.	Observatory	Date	(Rome—Observatory)[1]			Resulting (I. M. S.—Observatory)			Observatory instruments[2]	
			ΔD	$\frac{\Delta H}{H}$	ΔI	ΔD	$\frac{\Delta H}{H}$	ΔI	Magnetometer	Inclinometer
		1898	′		′	′		′		
10B	Kew..........	Sep. 2, 3.........	+0.7	−0.00033	−0.7	+0.4	−0.00008	−1.1	Jones........	Barrow DC. 33; 1, 2.
27	Parc St. Maur..	Aug. 25, 26, 27, 29.	−0.6	−0.00046	−1.9	−0.9	−0.00021	−2.3	Brunner(large)	Brunner DC.
		1902								
28	Pola...........	July 28, 29, 30....	−0.9	−0.00009	+1.3	{−1.2 −0.6	+0.00016} +0.00062}	+0.9	{Schneider..... Bamberg 7904[3]	}Wild EI.
24A	Potsdam.......	June 2, 3, 7.......	+0.3	+0.00026	+0.2	0.0	+0.00051	−0.2	Wanschaff....	Schulze EI. 1.

[1] The values given depend upon number of sets as follows: ΔD, twelve at each observatory except Kew where eight only; ΔH, two at each observatory (a set consisting of two sets of oscillations and two sets of deflections at two distances); ΔI, two at each observatory (a set with dip circle No. 51 consisting of the mean by the four needles 1, 2, 5, and 6).

[2] These data, except where given in Professor Palazzo's reports, taken from publication of each observatory for year concerned.

[3] The values of resulting (I. M. S.—Observatory) for Bamberg magnetometer 7904 are obtained by means of the published differences given by the Year Book of the Pola Observatory for 1903 (pages XXXIX-XLII), viz: [Pola (Bamberg No. 7904)—Pola (Schneider)] = −0′.57 (6 sets, January 1903), and [Pola (Bamberg No. 7904)—Pola (Schneider)] = −0.00046H (6 sets, December 1902).

The resulting values in Table 21A for (I. M. S. − Observatory) afford further evidence of some change in the intensity standard at Kew after 1910 (see p. 441); the values for ΔD and for ΔI are in excellent agreement with the direct determinations. There is also indication of a change in intensity standard at Greenwich and in the same direction as indicated by the two series in 1915 and 1919 (see pp. 423–426). Except for Falmouth and Kew the values of ΔD do not show good agreement with other values. At Val Joyeux magnetometer Chasselon No. 37 is the medium-size model after the design of the large Brunner instrument used at Parc St. Maur and is presumably the same as the instrument designated "Moureaux" in the 1910 comparisons by Kühl.[b] The corrections obtained for the Val Joyeux dip circle disagree. A third value may be obtained from Kühl's comparisons at Val Joyeux in 1910; he found the relation between the earth inductor and the dip circle to be

Earth inductor No. 61 = Val Joyeux dip circle + 2′.0

[a] Palazzo, L. Misure magnetiche e confronti magnetometrici a Terracina. *Ann. dell Uff. Centra. e Geod.*, vol. 37, 1920.

[b] Kühl, W. Vergleichung der Hauptbarometer und der magnetische absoluten Instrumente in de Bilt, Paris—Val Joyeux, und Pawlowsk mit denen in Berlin-Potsdam. Berlin, *Veröff. Met. Inst.*, No. 229, 1911, pp. 150–159. *Cf.* also *Res. Dep. Terr. Mag.*, Vol. II, p. 270.

whence, since from his work we have zero correction for earth inductor No. 61 on I. M. S.,

I. M. S. – Val Joyeux dip circle = +2′.0.

Thus there appears to have been some change in the dip circle at Val Joyeux in 1902, 1910, and 1913.

GENERAL SUMMARY AND CONCLUSIONS.

1. Tables A and B give general summaries of the results obtained both through direct comparisons by the Carnegie Institution of Washington at the observatory concerned and through indirect comparisons resulting from comparisons of other magnetic organizations.

TABLE A.—*Summary of Results of Direct Comparisons of Magnetic Observatory Standards, 1905–1921.*

[East declination and inclination of north end of needle below horizon are regarded as positive.]

Volume		Observatory	Approximate			Date	I. M. S.—Observatory			Grade of value			Observatory instruments	
II No.	IV No.		D	H	I		ΔD	$\frac{\Delta H}{H}$	ΔI	ΔD	$\frac{\Delta H}{H}$	ΔI	Magnetometer	Inclinometer
			°	c.g.s.	°		′		′					
1	1	Agincourt[1].....	− 7	.160	+75	1906–1915..	−1.3	+0.00039	−0.1	b	a	a	Elliott 98[2]....	EI. 89.
						1916–1921..	0.0	0.00000	0.0	b	a	a	Elliott 98[1]....	EI. 89[1].
3	—	Alibag.........	+ 1	.368	+24	1911.......	+0.3	−0.00108	−0.1	b	b	b	Cooke 7......	DC. 160.
4	—	Antipolo.......	+ 1	.382	+16	1912, Feb...	+1.8	−0.00214	+0.6	c	c	d	Elliott 28.....	DC. 7; 2.
6	—	Batavia........	+ 1	.367	−31	1911, Nov...	+0.5	+0.00122	+0.2	b	b	b	Mey., Jones 1[3]	EI. 47.
7	2	Cheltenham....	− 6	.196	+71	1908–1918..	0.0	−0.00006[4]	+0.8	a	a	a	Wild 26......	Wild EI. 26.
8	3	Christchurch...	+17	.224	−68	1906–1920..	+0.4	+0.00073	−1.1	a	a	b	Kew 1......	DC. 147; 1, 2, 3.
									−0.1			a		EI. 109.
—	4	Ottawa[5].......	−13	.150	+76	1915.......	+1.5	−0.00253	+0.6	b	b	b	Tesdorpf 1977.	DC. 145; 1, 2.
						1915.......	−0.3	+0.00106	−0.2	a	b	a	Cooke 15.....	EI. 1911.
9	—	Dehra Dun....	+ 3	.332	+44	1909, Oct...	0.0	+0.00144	+0.4	b	b	b	Elliott 17.....	EI. 30.
—	5	Eskdalemuir...	−18	.167	+70	1915, Sep...	−0.8	−0.00097	−0.1	b	b	a	Elliott 60.....	EI. 103.
10	—	Falmouth[6].....	−18	.188	+67	1909, Oct...	0.0	−0.00049	−0.8	b	b	b	Elliott 66.....	DC. 86; 1, 2.
—	6	Greenwich.....	−15	.185	+67	1915–1919..	−1.3	−0.00058	−0.7	b	b	b	Gibson 3[7].....	EI.
								−0.00119			d			
12	7	Helwan........	− 2	.300	+41	1908–1918..	+0.5	−0.00049	+1.2	b	b	b	Elliott 87.....	DC. 193; 3, 8.
13	8	Hongkong.....	0	.372	+31	1908–1915..	+0.9	+0.00109	−0.8	c	c	c	Elliott 55.....	DC. 71; 3, 4, 7, 8.
—	9	Honolulu......	+10	.289	+39	1915–1921..	0.0	−0.00003	+0.1	a	a	a	Cooke 36.....	EI. 4.
14	10	Kew..........	−15	.184	+67	1908–1919..	+0.3	−0.00008	−0.8	a	a	a	Jones........	DC. 33; 1, 2.
								−0.00046			b			
								−0.00109			c			
15	—	Mauritius......	− 9	.233	−53	1911, Aug...	+0.4	−0.00065	+0.3[9]	b	b	b	Elliott 24....	EI. 4.
—	11	Loanda........	−15	.249	−37	1920, Mar...	+2.2	....	+4.6	d	...	d	Elliott 200....	DC. 115; 1.
29	12	Lukiapang[10]....	− 3	.332	+46	1907–1917..	−1.3	+0.00068	−0.4	b	c	b	Elliott 49.....	DC. 33; 14.
								+0.00175	0.0		d	b		EI. 42.
17	13	Pilar..........	+ 9	.255	−26	1911, Aug...	+0.4	−0.00101	+0.3	b	b	b	Dover 138....	DC. 216; EI. 3.
						1913–1917..	−0.6	−0.00033	−0.1	a	a	a	Dover 175....	EI. 3.
18	—	Pola..........	− 9	.222	+60	1910, Feb...	−0.4	+0.00039	+0.6	b	b	b	Bamberg 7904	Wild EI.
19	—	Porto Rico[8]....	− 2	.288	+50	1910, Jul....	+0.5	+0.00003[4]	+1.0[11]	b	c	b	Cooke 31.....	EI. 1.
20	—	Potsdam.......	− 9	.188	+66	1910, Feb...	+0.2	+0.00008	+0.2	a	a	a	Wanschaff....	EI. (Schulze 1).
21	14	Rio de Janeiro..	−10	.246	−15	1913–1919..	+0.5	−0.00029	−0.7	b	b	c	Cooke 20.....	DC. 8075; 1, 2.
							0.0	−0.0034	−0.7	b	b	c	Cooke 25.....	DC. 221; 1, 2, 2.
22	15	Rome[12]........	− 8	.238	+57	1911–1913..	−0.3	+0.00025	−0.4	a	a	a	Dover 122....	DC. 51; 1, 2, 5, 6.
23	16	Samoa.........	+10	.353	−29	1905–1921..	−3.0	+0.00012	+0.7	b	b	b	Tesdorpf 2025.	EI. 2.
—	17	Stonyhurst.....	−17	.173	+69	1915, Sep...	0.0	+0.00010	−1.4	b	b	b	Jones........	DC. 159; 1, 2.
—	18	Tananarive....	− 8	.221	−53	1920, Nov...	+5.4	−0.0037	+4.5	d	d	d	Brunner......	DC.
—	19	Watheroo[13].....	− 4	.249	−64	1920, Sep...	+0.1	+0.00015	0.0	a	a	a	C.I.W. 7.....	EI. 2 (C.I.W.)
27	20	Washington....	− 5	.190	+71	1907–1921..	−0.1	0.00000	0.0	a	a	a	C.I.W. 3.....	EI. 48.
28	—	Zikawei........	− 3	.331	+46	1907.......	−1.1	+0.00042	−0.4	b	b	b	Elliott 49.....	DC. 33: 14.

[1] Beginning with January 1916 published results for Agincourt are reduced to I. M. S. and to the horizontal-intensity station. (See page 400.)

[2] Elliott 98 corrected for H (see Vol. II, page 216, equation VI); for D, Toronto declinometer is used.

[3] Reconstructed Meyerstein unifilar for D; Jones magnetometer 1 for H.

[4] Standard in H since 1913 is $0.001H$ less than that previously used (see page 407).

[5] Through observations made at Washington, Agincourt, and Ottawa.

[6] Brick pier of absolute observatory later reported to have been found magnetic by Mr. L. F. Richardson (see British Meteorological and Magnetic Year Book for 1913, part IV, section 2, page 86).

[7] Declinometer used for D.

[8] Referred by the United States Coast and Geodetic Survey to the Cheltenham standards.

[9] This is correction as determined at Washington in 1913 (see vol. II, page 264).

[10] Succeeded Zikawei in March 1908.

[11] See foot-note 3, page 407.

[12] Values given supersede those published in Volume II, pages 254 to 256 (see page 451).

[13] Referred by the Department of Terrestrial Magnetism to I. M. S.

TABLE B.—*Summary of Results of Indirect Comparisons of Magnetic Observatory Standards.*[1]

[East declination and inclination of north end of needle below horizon are regarded as positive.]

Volume		Observatory	Approximate			Date	I. M. S.—Observatory			Grade of value			Observatory instruments	
II No.	IV No.		D	H	I		ΔD	$\frac{\Delta H}{H}$	ΔI	ΔD	$\frac{\Delta H}{H}$	ΔI	Magnetometer	Inclinometer
			°	*c.g.s.*	°		′		′					
31	....	De Bilt	−13	.185	+67	1910, June..	+0.5	−0.00013	−1.0	*c*	*c*	*c*	Edelmann[2]	DC.
....	22	De Bilt	−13	.185	+67	1913, July...	−1.4	−0.00037	+0.7 +1.2	*d*	*c*	*c* *c*	Edelmann[2]	Weber EI. Schulze EI. 88.
10	23	Falmouth[3]	−17	.188	+66	1913, Jun, Jul	−0.1	−0.00023	+0.2	*c*	*c*	*c*	Elliott 66.....	Dover DC. 86; 1, 2.
....	6A	Greenwich	−16	.185	+67	1913, June..	....	+0.00071	−0.8	...	*c*	*c*	Gibson 3[4].....	EI.
32	....	Irkutsk	+ 2	.199	+70	1908, July...	....	+0.00022	−1.3	...	*c*	*c*	Wild-Freiberg.	W-E. EI.
33	....	Katherinenburg	+11	.176	+71	1908, June..	....	+0.00029	+0.2	...	*c*	*c*	Wild-Freiberg.	W-E. EI.
14	10B	Kew[5]	−17	.184	+67	1898, Sep...	+0.4	−0.00008	−1.1	*c*	*c*	*c*	Jones........	Barrow DC. 33; 1, 2.
14	10A	Kew[5]	−16	.185	+67	1913, June..	+0.5	−0.00074	−0.7	*c*	*c*	*c*	Jones........	Barrow DC. 33; 1, 2.
....	21	Meanook	+28	.129	+78	1917, Sep...	−0.5	+0.00031	0.0	*c*	*c*	*c*	Elliott 48.....	Dover DC. 200; 1, 2.
....	27	Parc St. Maur..	−15	.197	+65	1898, Aug...	−0.9	−0.00021	−2.3	*c*	*c*	*c*	Brunner (large model)	Brunner DC.
34	....	Pavlovsk	+ 1	.166	+71	1908–1910...	0.0	+0.00031	−0.3	*c*	*c*	*c*	Wild-Freiberg[4]	EI.
18	28	Pola	− 9	.222	+60	1902, July..	−1.2 −0.6	+0.00016 +0.00062	+0.9	*c*	*c*	*c*	Schneider..... Bamberg 7904	Wild EI.
20	24A	Potsdam	−10	.189	+66	1902, June..	0.0	+0.00051	−0.2	*c*	*c*	*c*	Wanschaff....	Schulze EI. 1.
20	24	Potsdam	− 9	.188	+66	1913, July...	−1.6(?)	−0.00058	+0.8[6]	?	*c*	*c*	Wanschaff....	Schulze EI. 1.
35	....	Rude Skov	−10	.174	+69	1908, Sep...	+0.2	+0.00084	−0.8	*c*	*c*	*c*	Bamberg 1973	W-E. EI.
25A	....	Tiflis (Karsani).	+ 3	.254	+56	1907, Dec...	....	+0.00031	+0.1	...	*c*	*c*	Wild-Edelmann.......	W-E. EI.
36	....	Upsala	−11	.164	+71	1908, Sep...	....	−0.00024	−0.5	...	*c*	*c*	Lamont......	DC. 60; 3, 4.
....	26	Valencia	−20	.179	+68	1913, June..	+1.3	−0.00015	+0.6	*c*	*c*	*c*	Dover 139....	Dover DC. 118.
37	....	Val Joyeux....	−14	.197	+65	1910, June..	+0.7	−0.00127	0.0 +2.0	*c*	*c*	*c* *c*	Moureaux....	EI. 61. Brunner DC.
37	25	Val Joyeux....	−14	.198	+65	1913, July...	−1.1	−0.00099	+4.5	*c*	*c*	*c*	Chasselon 37[7]	Brunner DC.

[1] For previous values see *Res. Dep. Terr. Mag.*, Vol. II, page 278.
[2] The declinations are observed with a special declinometer.
[3] See foot-note 4 of Table 21A.
[4] Special declinometer for declination.
[5] See also No. 10 of Table A.
[6] See page 473.
[7] Probably same as magnetometer designated "Moureaux" for the 1910 results.

2. The accumulated data show that the provisional international magnetic standards adopted for the work of the Carnegie Institution of Washington are absolute to a precision well within the magnitude of the unavoidable errors of observation and of determination of constants for the various types of instruments used.

3. The absolute precision obtainable with carefully designed magnetometers and inductors, provided instruments are carefully used and comparisons are made with reliable standards at least every two or three years, is of the order 0′.2 in declination and inclination and of the order 0.00015H in horizontal intensity.

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